



**FLUOR DANIEL GTI**

## **REMEDIAL INVESTIGATION REPORT**

General Motors - Allison Plant 10  
700 North Olin Avenue  
Indianapolis, Indiana

# 6991004

# **DRAFT**

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Prepared For  
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## TABLE OF CONTENTS

1.0	INTRODUCTION .....	1
1.1	Site Description .....	1
1.2	Site Physical Features .....	2
1.3	Land Use and Population .....	2
1.4	Water Resources and Climate .....	2
1.5	Ecological Survey .....	3
1.6	Site History and Previous Investigations .....	4
2.0	PHASE III FIELD INVESTIGATION PROCEDURES .....	5
2.1	Health and Safety Plan .....	5
2.2	Monitoring Well Installation .....	6
2.3	Hydropunch and Geoprobe Sampling .....	8
2.4	Stream Gauge Installation/Measurements .....	8
2.5	Well and Stream Gauge Survey .....	8
2.6	Rising Head Permeability Tests .....	9
2.7	Groundwater Monitoring and Sampling .....	9
2.8	Stream Flow Measurements/Water Sampling .....	10
3.0	PHYSICAL CHARACTERISTICS OF THE SITE .....	11
3.1	Geology .....	11
3.2	Hydrogeology .....	11
4.0	RESULTS .....	14
4.1	Soil Analytical Results .....	14
4.1.1	Surface Soils (0-2 feet) .....	14
4.1.2	Vadose Zone (2-10 feet) .....	15
4.1.3	Saturated Zone (>10 feet) .....	16
4.2	Groundwater Analytical Results .....	16
4.2.1	Monitoring Wells and Hydropunch .....	17
4.2.2	Little Eagle Creek Surface Water Sampling .....	17
4.3	Aquifer-Stream Interaction .....	17
4.3.1	Stream Flow .....	17
4.3.2	Chemical Mass Loading to Little Eagle Creek .....	18
5.0	BASELINE RISK ASSESSMENT .....	21
5.1	Data Evaluation .....	21
5.1.1	Data Gaps .....	24
5.1.2	Vadose Zone Soils .....	26
5.1.3	Groundwater .....	29
5.1.4	Surface Water .....	30
5.1.5	Uncertainties Associated with Data Collection and Evaluation .....	31
5.2	Tier III Site-Specific Risk Assessment .....	31
5.2.1	Land Use .....	32
5.2.2	Potential Human Receptors .....	33
5.2.3	Exposure Pathways .....	34

95824kg



5.2.3.1	Soils	34
5.2.3.2	Groundwater	35
5.2.3.3	Surface Water	36
5.2.4	Quantify Exposure Pathways	37
5.2.4.1	COI-Related Variables	38
5.2.4.2	Exposed Population Variables	39
5.2.4.3	Exposure Scenario Variables	40
5.2.5	Uncertainties Associated with Exposure Assessment	41
5.2.6	Toxicity Assessment	41
5.2.6.1	Toxicity Values for Noncarcinogenic Effects	42
5.2.6.2	Toxicity Values for Carcinogenic Effects	43
5.2.6.3	Toxicity Information for COI	43
5.2.7	Uncertainties Associated with the Toxicity Assessment	44
5.2.8	Calculation of Tier III Human Health Carcinogenic and Non-carcinogenic Risks	44
5.2.8.1	Tier III Non-Residential Risks	46
5.2.8.2	Tier III Residential Risks	46
5.3	Risk Assessment Conclusions	47
6.0	SUMMARY & CONCLUSIONS	48
7.0	RECOMMENDATIONS	52
8.0	REFERENCES	53

## FIGURES

SITE LOCATION MAP .....	FIGURE 1
SITE MAP .....	FIGURE 2
VICINITY MAP .....	FIGURE 3
DOMESTIC & MUNICIPAL WELL LOCATION MAP .....	FIGURE 4
CROSS SECTION LOCATION MAP .....	FIGURE 5
GEOLOGIC CROSS SECTIONS A-A' AND B-B' .....	FIGURE 5A
GEOLOGIC CROSS SECTIONS C-C' .....	FIGURE 5B
POTENTIOMETRIC SURFACE MAP - JULY 14, 1995 .....	FIGURE 6A
POTENTIOMETRIC SURFACE MAP - SEPTEMBER 11, 1995 .....	FIGURE 6B
POTENTIOMETRIC SURFACE MAP - FEBRUARY 5-6, 1997 .....	FIGURE 6C
TCE, VC, & 1,2-DCE IN VADOSE SOIL (HISTORICAL DATA) .....	FIGURE 7
TCE, VC, & 1,2-DCE IN GROUNDWATER (JULY 14-17 & SEPTEMBER 11, 1995) .....	FIGURE 8A
VOC CONCENTRATIONS IN GROUNDWATER (FEBRUARY 5, 6 AND 26, 1997) .....	FIGURE 8B
TRICHLOROETHENE IN GROUNDWATER - 7/95 & 9/95 .....	FIGURE 9
VINYL CHLORIDE IN GROUNDWATER - 7/95 & 9/95 .....	FIGURE 10
DICHLOROETHENE IN GROUNDWATER - 7/95 & 9/95 .....	FIGURE 11
VOC CONCENTRATIONS IN CREEK (10/4/96 & 2/10/97) .....	FIGURE 12
FLOW DIRECTION IN MIDDLE CONFINED AQUIFER .....	FIGURE 13
STREAM LOADING FOR CIS 1,2-DICHLOROETHENE .....	FIGURE 14

## TABLES

SUMMARY OF DETECTED VOC CONCENTRATIONS IN SOIL - HISTORICAL DATA .....	TABLE 1
SUMMARY OF DETECTED METAL CONCENTRATIONS IN SOIL - HISTORICAL DATA .....	TABLE 1B
SUMMARY OF WELL GAUGING DATA .....	TABLE 2
SLUG TEST ANALYSIS DATA .....	TABLE 3
AQUIFER HYDRAULIC CONDUCTIVITY SUMMARY .....	TABLE 4
SUMMARY OF SOIL VAPOR HEADSPACE READINGS .....	TABLE 5
SUMMARY OF DETECTED VOC CONCENTRATIONS IN SOIL FOR WELLS AND BORINGS INSTALLED BY FLUOR DANIEL GTI .....	TABLE 6
SUMMARY OF PRIORITY POLLUTANT METAL CONCENTRATIONS IN SOIL FOR GEOPROBE BORINGS INSTALLED BY FLUOR DANIEL GTI - DECEMBER 19, 1996 .....	TABLE 6B
SUMMARY OF DETECTED VOC CONCENTRATIONS IN GROUNDWATER FOR MONITORING WELLS - HISTORICAL DATA .....	TABLE 7
SUMMARY OF DETECTED VOC CONCENTRATIONS IN SURFACE WATER IN LITTLE EAGLE CREEK .....	TABLE 7B
LITTLE EAGLE CREEK FLOW SUMMARY .....	TABLE 8
SUMMARY OF SOIL LITERATURE BACKGROUND RANGES FOR TIER I METALS EVALUATIONS .....	TABLE 9
SOIL FREQUENCY AND STATISTICAL SUMMARY ON-SITE VADOSE ZONE SUBSURFACE SOIL DATA .....	TABLE 10
SOIL FREQUENCY AND STATISTICAL SUMMARY OFF-SITE VADOSE ZONE SUBSURFACE SOIL DATA .....	TABLE 11

SURFACE AND SUBSURFACE SOIL LEAD & ASBESTOS STATISTICAL EVALUATIONS . . .	TABLE 12
GROUNDWATER FREQUENCY SUMMARY ON-SITE	
AND OFF-SITE GROUNDWATER DATA . . . . .	TABLE 13
CALCULATION OF SOIL-TO-AIR VOLATILIZATION FACTOR... SOILS EXPOSURE . . . . .	TABLE 14
CALCULATION OF GROUNDWATER-TO-INDOOR AIR...GROUNDWATER EXPOSURE . . .	TABLE 15
SUMMARY OF CARCINOGENIC...SURFACE SOILS...ON-SITE WORKERS . . . . .	TABLE 16
SUMMARY OF CARCINOGENIC...SUBSURFACE SOILS...ON-SITE WORKERS . . . . .	TABLE 17
SUMMARY OF CARCINOGENIC...ON-SITE CONSTRUCTION WORKERS . . . . .	TABLE 18
SUMMARY OF CARCINOGENIC...SURFACE WATER...CHILD RESIDENTIAL . . . . .	TABLE 19
SUMMARY OF CARCINOGENIC...VOLATILES...OFF-SITE GROUNDWATER . . . . .	TABLE 20
SUMMARY OF CARCINOGENIC...HUMAN HEALTH...GROUPS ASSESSED . . . . .	TABLE 21

## APPENDICES

DOMESTIC WELL LOGS . . . . .	APPENDIX A
DOMESTIC WELL ANALYTICAL DATA . . . . .	APPENDIX B
DRILLING LOGS . . . . .	APPENDIX C
RISING HEAD PERMEABILITY TEST DATA . . . . .	APPENDIX D
SOIL ANALYTICAL RESULTS . . . . .	APPENDIX E
WATER ANALYTICAL RESULTS . . . . .	APPENDIX F
STREAM DISCHARGE DATA . . . . .	APPENDIX G



## 1.0 INTRODUCTION

Fluor Daniel GTI, Inc. has prepared this Remedial Investigation Report for The Allison Engine Company Plant 10 located at 700 North Olin Avenue in Indianapolis, Indiana. The location of the property is depicted on Figure 1. The scope of work has been completed, and when considered as a whole, is consistent with the National Contingency Plan as referenced in 40 CFR 300.700 (Subpart H-Participation by Other Persons). The purpose of the investigation was to better define the magnitude and extent of volatile organic compounds (VOC) in the soil and groundwater and to assess potential environmental risks to their occurrence. Metals in surface soil were also investigated. Objectives of the investigation were to:

- 1) determine the vertical and horizontal extent and magnitude of VOC occurrence in soil and groundwater at the site.
- 2) determine the horizontal extent and magnitude of VOC occurrence in soil and groundwater off-site to the east, west, and south.
- 3) delineate the vertical extent of VOC occurrence in soil and groundwater off-site to the southeast.
- 4) investigate the presence of VOC in Little Eagle Creek.
- 5) investigate metals in surface soil on site.
- 5) assess the potential threat of VOC and metals occurrence to human health and the environment.

Activities completed during the investigation included the advancement of fourteen soil borings, one Hydropunch, and six Geoprobe borings; collection of soil samples for laboratory analysis; the installation of nine shallow and five deep groundwater monitoring wells in the fourteen borings; surveying of all new wells; groundwater elevation monitoring and sampling of all wells on-site; stream survey and sampling of Little Eagle Creek; and rising head permeability tests from the newly installed wells. Results of the investigation were used to more fully characterize the geology and hydrogeology of the site, to further delineate VOC and metals occurrence, and to assess the potential risk of VOC and metals occurrence to human health and the environment.

### 1.1 Site Description

The subject property is the site of the former General Motors Corporation Allison Gas Turbine Division (AGT) Plant 10. This plant was purchased by General Motors from BHT Corporation (BHT) for use as a warehouse for obsolete machines, tooling, and fixtures in 1973. Prior to 1973, the facility was operated as a carburetor remanufacturing and brake overhaul facility by BHT. The original building was constructed in 1956 and renovated in 1970, doubling the floor space. The facility was used as a warehouse by General Motors until the mid 1980s at which time it became part of the AGT Division and continued to be managed as a warehouse. The property was then sold to the Allison Engine Company in December 1993 as part of the sale of AGT.



## 1.2 Site Physical Features

The site is located on the southwest side of Indianapolis, Indiana in Marion County on the Tipton Till Plain. The surface topography over most of the site is relatively flat. The southern third of the site slopes moderately to the south, towards Little Eagle Creek. Site elevations range from approximately 715 feet above mean sea level (MSL) at the north end of the property to 705 feet above MSL near Little Eagle Creek.

The site is occupied by a single warehouse. The area surrounding the warehouse is covered by asphalt and concrete. The western and southern sections of the property are grass with wooded areas. A site map showing salient site features is presented as Figure 2.

## 1.3 Land Use and Population

The property is zoned industrial and is currently leased from Allison Engine Company by a subsidiary of Genuine Parts Company, for use as a warehouse and distribution center. Land use in the surrounding area of the site is mixed use with zoning predominantly residential, general business, and industrial. The property is bordered by a wooded area, Little Eagle Creek, and Michigan Meadows Apartments to the south, a residential neighborhood to the east, a city park (Olin Park) to the north, and Holt Road and an Allison Transmission Plant to the west. Features of the surrounding area are presented on the Vicinity Map (Figure 3).

## 1.4 Water Resources and Climate

Fluor Daniel GTI obtained all available drilling logs of domestic water wells on record at the Indiana Department of Natural Resources, Division of Water. A total of 160 domestic wells were identified as being located within a one mile radius of the subject site, the nearest of which lies approximately 1,000 feet north (upgradient) of the property. The wells are completed within limestone bedrock, clay, or sand and gravel units at depths ranging from 30 to 270 feet below grade (bg). Records indicate the Allison Transmission Plant across Holt Road to the west has two water supply wells, the nearest of which lies approximately 1,600 feet northwest of the site (cross-gradient). The majority of the water supply wells identified are located to the north, west, and south of the site. A total of 47 municipal or high capacity wells were identified as being located within a two mile radius of the subject site, with 17 of those located within a one mile radius. The nearest of these wells lies approximately 1,400 feet northwest of the site

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along Little Eagle Creek (cross-gradient). Refer to Figure 4 for approximate locations of the domestic and municipal wells. The completion logs for the domestic wells are presented in Appendix A.

Potable water is supplied to the area by the Indianapolis Water Company (IWC). The water supply is drawn from numerous wells in the area, the majority of which are located along Eagle Creek approximately 1.5 miles west (upstream) of the subject site. A discussion with the Supervisor of Customer Contact at IWC indicated that residences across Olin Avenue to the east and the Michigan Meadows Apartment complex across Little Eagle Creek to the south are supplied by IWC. A house to house survey of local residences along the east side of Olin and the west side of Luett Avenues was conducted by the Marion County Health Department (MCHD) in December, 1996. A single domestic well was located at 709 North Olin Avenue. The construction of the well is unknown. This well was not identified during the well search conducted at the Department of Natural Resources. Only well logs completed by the drillers and submitted to IDNR are found in the IDNR's files. The approximate location of this domestic well is provided on Figure 3. The well was sampled by MCHD on January 2, 1997. The analytical results indicate that volatile organics are not present in this water supply. These results are included in Appendix B.

The nearest body of surface water is Little Eagle Creek located adjacent to the southern property boundary. This creek flows towards the east-southeast and eventually joins with Eagle Creek approximately one mile to the south of the site.

Indianapolis has a temperate climate with warm summers and no dry season. Precipitation is distributed fairly evenly through out the year. The average precipitation is 39.99 inches per year and the average annual temperature is 52.5° F. (NOAA, 1989). Over a 29 year period from 1960 to 1989 the average monthly rainfall ranged from a low of 2.69 inches in October to a high of 4.03 inches in June. Average temperature for the same period ranged from a low of 28.0° F in January to a high of 75.8° F in July. Spring and early summer rains usually exceed winter precipitation. (Sturm and Gilbert, 1978).

### 1.5 Ecological Survey

A desktop ecological survey was completed by Fluor Daniel GTI personnel. The nearest body of surface water is Little Eagle Creek which flows across the southern boundary of the property. The National Wetlands Inventory Map was obtained for the Indianapolis West Quadrangle (USDI, 1990). These maps are compiled using high altitude aerial photographs and therefore, have a margin of error. The wetlands map identifies Little Eagle Creek as riverain, lower perennial, unconsolidated bottom, and permanently flooded. This area had not been field examined at the time the map was printed.





A letter regarding the site from Mr. David Hudak of the United States Fish and Wildlife Service stated that the area is located within the range of the Federally endangered Indiana bat and peregrine falcon, and Federally threatened bald eagle.

"The Indiana bat uses woodlands during the summer when maternity colonies utilize trees with loose bark for nesting. These bats forage primarily over wooded stream corridors, although they have been collected in grazed woodlots, mature deciduous forests, and pastures with trees. A survey done in 1993 by our office found Indiana bats in the northeast section of Marion County."

"Peregrin falcon habitat is usually described as open country along large rivers, lakes, and coastlines. High cliffs or bluffs are often used as nest sites, however, breeding is also presently occurring on high buildings, bridges, and other man-made structures in cities". None of these features appear to be present in the study area.

"Eagles nest in close proximity to lakes, rivers, and reservoirs. They construct their nests near habitat ecotones, such as lakeshores, rivers, and timber management areas." The site does not appear to be in close proximity to this habitat.

#### 1.6 Site History and Previous Investigations

Two environmental investigations were completed at this property by Engineering Science, Inc. (ESI) in 1992. The initial investigation, entitled *Phase I Information Review Report for General Motors Corporation Allison Gas Turbine Division*, was completed by ESI in July of 1992. This assessment involved no intrusive exploration of environmental conditions. The Phase I assessment identified the following potential areas of environmental concern:

- two reported releases (100 gallons of quench oil in the southwest corner of the property and an unknown amount of hydraulic fluid in the southwest courtyard);
- possible waste burial area at western end of property; and
- possible area of dumping near the northwest corner of the plant.

The above ground storage tanks were reported to be in good condition. The Phase I identified the Plant 10 site as a potential area of concern (PAOC). The report included a recommendation to install three monitoring wells and one soil boring.



An intrusive follow-up assessment of the areas of environmental concern identified during the Phase I assessment was completed by ESI in November of 1993. Methods and results of this additional investigation were reported in a document titled *Phase II Site Assessment Final Report for General Motors Corporation Allison Gas Turbine Division* dated November 19, 1993. During the initial phase of work, three monitoring wells (MW-132, MW-133, and MW-135) were installed and one soil boring (SB-134) was advanced at the site. A soil gas survey was completed on the west side of the property during this investigation. During the second phase of this investigation four monitoring wells (MW-145 through MW-148) were installed and two soil borings (SB-149 and SB-150) were advanced on-site.

Results of this investigation identified trichloroethene (TCE), vinyl chloride (VC), 1,2-dichloroethene (1,2-DCE), tetrachloroethene (PCE), toluene, and methylene chloride in the soil on-site. Compounds most frequently detected included TCE, 1,2-DCE, and VC. Analytical results for the soil sampling are presented in Table 1. The west side of the site was confirmed as a PAOC during the Phase II investigation, however the source was unknown.

O'Brien and Gere Engineers, Inc. (OBG) conducted a Buyer Environmental Assessment for Plant 10 in May, 1994. They advanced six soil borings (SB-10-1 through SB-10-5 and OBG-10-1) and installed one monitoring well MW-10-1 in soil boring OBG-10-1. Surface samples collected included two surface soil samples near an area containing brake pad pieces, two brake pad samples for asbestos testing, and two sludge samples from the sumps located south of the building. These sumps have since been removed. A total of six subsurface soil samples and three groundwater samples were also collected. VOC and metals analytical results for the subsurface soil sampling are presented in Tables 1 and 1B, respectively.

## 2.0 PHASE III FIELD INVESTIGATION PROCEDURES

Fluor Daniel GTI conducted an expanded subsurface investigation at this site in July 1995, September 1995, and February 1997. The purpose of the investigation was to further characterize the site hydrogeology, to delineate the extent and magnitude of the VOC occurrence in soil and groundwater, and to investigate metals occurrence in surface soil.

### 2.1 Health and Safety Plan

Before implementation of field work, a site specific Health and Safety Plan was prepared by Fluor Daniel GTI to comply with the OSHA Standard, "Hazardous Waste Operations and Emergency Response," (29 CFR 1910.120) and state and local procedures. Fluor Daniel GTI personnel who performed site work are certified as completing a 40 hour OSHA training course for hazardous waste activities. Additionally, employees have completed an annual eight hour refresher course. Copies of all certifications are kept on

file with the Fluor Daniel GTI, Inc. corporate office of Health and Safety and with the employee's Fluor Daniel GTI branch office.

## 2.2 Monitoring Well Installation

Fourteen monitoring wells were installed on and off-site as part of this investigation. Well locations are provided on Figure 2. Monitoring wells MW-150 through MW-154 and MW-200 through MW-202 were installed during the time period of June 27 through July 11, 1995 by subcontractors Haskett Drilling and Earth Exploration, Inc. with Fluor Daniel GTI providing technical environmental assistance. Additional subsurface investigations included the installation of monitoring wells MW-155, MW-156 on September 5 and 6, 1995; and the installation of monitoring wells MW-157, MW-158, MW-301, and MW-302 on January 22 through January 31, 1997. The wells were installed with completion depths ranging from 19 to 55 feet below grade (bg) utilizing truck and all terrain vehicle (ATV) mounted hollow-stem auger drill rigs. Wells MW-150 through MW-158 were installed to further delineate (laterally) VOCs in the groundwater both on and off-site. Double cased wells MW-200, MW-202, and MW-302 were installed to vertically delineate VOCs in the groundwater to the southwest and southeast of the facility. MW-201 and MW-301 were installed off-site to the southeast to vertically delineate VOC occurrence in that direction. Well locations are shown on Figure 2.

Soil samples were collected at five foot intervals (from 3 feet below surface to boring terminus) for MW-152, MW-154 through MW-158, MW-200 through MW-202, and MW-301 and MW-302. Wells MW-150, MW-151, and MW-153 were installed as part of well clusters where soil samples were collected during the installation of the other wells of the cluster. During advancement of the borings, soil samples were collected by advancing hollow-stem augers and driving a 1.25-inch diameter, 2 foot long split-spoon sampler through the sampling interval. The split spoon sampler was driven into the soil using a 140 pound hammer with a free-fall of approximately 30 inches in accordance with ASTM standards. The number of blows required to advance the split spoon in 6-inch increments were recorded on the boring log (Appendix C). Soils encountered during drilling were logged by a geologist with respect to grain size, moisture content, density, and color using the Unified Soil Classification System (USCS).

Each soil sample was separated into two representative portions and placed in plastic zippered bags. Any organic vapors present in the sample were allowed to equilibrate in one of the tightly sealed bags for approximately 10-15 minutes. The organic vapor concentration in the headspace of the container was then measured using a photo-ionization detector (PID) with a 10.2 eV lamp or a flame ionization detector (FID). The second bag was kept on ice pending packing in glass jars for laboratory analysis. Soil samples from the location of highest PID/FID response and from the bottom of each boring or from the zone above the water table were submitted to GTEL Environmental Laboratories, Inc (GTEL) of Wichita, Kansas for VOC analysis using EPA Method 8240.

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All sampling equipment was decontaminated after each boring by washing with a laboratory grade detergent solution and rinsing with water. Augers were cleaned with pressurized steam after each use. All decontamination fluids were collected, placed in drums, labeled and stored on the site for disposal by the owner.

The monitoring wells MW-150 through MW-158 were completed to depths ranging from 19 feet to 29 feet bg and were constructed of two-inch diameter, schedule 40 PVC flush-threaded casing, with 0.020-inch machine slotted schedule 40 PVC screen. The annular space around each well was backfilled with clean silica sand to approximately 1 foot above the top of the screen above which was placed a bentonite seal. The wells were completed with a concrete cap to surface grade and either a flush mounted well box or a stand pipe protective cover. A locking cap was placed on each wellhead. Well construction details are included with the drilling logs in Appendix C.

The deep wells (MW-200 through MW-202) were completed to depths ranging from 35 feet to 50 feet bg. These monitoring wells were installed in accordance with Section 3.3.5 of the Fluor Daniel GTI work plan dated June 20, 1995. Since the clay unit was less than 10 feet thick at MW-200, the well was set at 50 feet bg. Since the clay was greater than 10 feet at the other two locations, MW-201 and MW-202 were set within the clay unit itself. Wells MW-301 and MW-302 were later installed near MW-201 and MW-202, respectively, to intercept the lower sand unit. Well MW-301 was set within the lower sand unit, however, this unit was not present in the vicinity of MW-302. The well screen of MW-302 was set approximately 10 to 20 feet below MW-202 and its screen intercepts an approximately 0.5 feet sand layer. The wells were constructed of two-inch diameter, schedule 40 PVC flush-threaded casing, with 0.020-inch machine slotted schedule 40 PVC screen. These wells were double cased to 25 feet with ten-inch diameter, schedule 40 PVC flush-threaded casing. The outer casing was set with a half foot of bentonite seal at the bottom and a bentonite/portland grout to approximately 6 feet bg. This was allowed to set up for approximately 48 hours. The annular space around each inner well was backfilled with clean silica sand to approximately 1 foot above the top of the screen above which was placed a two foot bentonite seal. The wells were completed with bentonite/portland grout and a concrete cap to surface grade and either a flush mounted well box (MW-200, MW-201, and MW-301) or a stand pipe protective cover (MW-202 and MW-302).

### 2.3 Hydropunch and Geoprobe Sampling

One Hydropunch boring (HP-1) was advanced on September 6, 1995 and six Geoprobe borings (GP-1 through GP-6) were advanced on December 19, 1996 by Earth Exploration, Inc. with Fluor Daniel GTI providing technical environmental assistance. The Hydropunch was advanced to a total depth of approximately 7 feet, and a water sample was collected before the boring was backfilled. Geoprobe borings were advanced to a total depth of 12 feet by utilizing a truck mounted Geoprobe rig. The Geoprobe borings were backfilled with bentonite after sample collection. Geoprobos GP-1 through GP-6, and Hydropunch HP-1 were installed to further delineate (laterally) VOCs in the groundwater both on and off-site. Surface soil samples were also collected from the Geoprobe borings for metals analysis. Geoprobe and Hydropunch locations are shown on Figure 2.

Soil samples were collected at five foot intervals (from 3 feet below surface to boring terminus) for HP-1 and GP-1 through GP-6. HP-1 was sampled in the same manner as the monitoring wells. Soil samples from the Geoprobe borings were collected by hydraulically driving a 1.25-inch diameter, piston-type sampler to the desired sampling interval. The piston within the sampler was released and the plastic-lined sampler was advanced through the sampling interval.

Samples were collected and screened in the field using the same methods utilized for the monitoring well samples. In addition to EPA Method 8240, samples from the Geoprobe borings were also analyzed for priority pollutant metals by appropriate EPA 6000/7000 series method.

### 2.4 Stream Gauge Installation/Measurements

On February 24, 1997, two stream gauges were attached to concrete bridge supports along Little Eagle Creek in order to correlate the creek level with the depth to water in the monitoring wells. One gauge (SG-1) was attached to a bridge support beneath Holt Road, west (upstream) of the site. The second gauge (SG-2) was attached to an abandoned support near the end of Olin Avenue, east (downstream) of the site. SG-1 was attached with an adhesive and SG-2 was attached with screws. Fluor Daniel GTI personnel surveyed the elevation of the tops of the gauges relative to nearby monitoring wells. The stream levels were read off of the stream gauges on February 26, 1997. At this time a partial gauging was done on the wells on site in order to correlate the water levels in the wells with the stream level.

### 2.5 Well and Stream Gauge Survey

On July 14-17, 1995, monitoring wells MW-150 through MW-154 and MW-200 through MW-202 were surveyed for top of casing (TOC) elevation by Fluor Daniel GTI personnel. TOC elevations of wells MW-155 and MW-156 were surveyed on September 11, 1995, and those of wells MW-157, MW-158, MW-301,

and MW-302 were surveyed on February 4, 1997. The stream gauges were surveyed in on February 26, 1997 by surveying the point on the top of the bridge/support directly above the gauge and measuring the distance to the top of the gauge. Well and stream gauge elevations were measured relative to pre-existing monitoring wells with known elevations using an engineers level. Well TOC elevations are presented in Table 2.

## 2.6 Rising Head Permeability Tests

Rising-head permeability tests were performed in nine monitoring wells to evaluate the hydraulic characteristics of the shallow and deep aquifers and the inter-lying clay. The rising-head permeability tests involved the rapid removal of a volume of water to lower the level of the water below that measured at static conditions. The rate at which the water level returned to static conditions was then observed by periodically measuring the water level in the test well and recording the elapsed time since the removal of the slug. The tests in the wells screened in the sand aquifers were conducted utilizing a Hermit 2000 data logger with a pressure transducer to measure the rising head. The wells screened within the clay unit were tested by removing a slug of water with a bailer and measuring the rising head utilizing an interface probe (IP). This method was used in the clay unit based on the slow rate of water recovery in the wells.

The rising-head permeability tests were conducted in wells MW-150, MW-151, MW-153, MW-154, MW-200 through MW-202, MW-301, and MW-302 on February 24, 1997. The static water level in each of the selected test wells was measured and recorded prior to initiation of the tests. A 1.25 inch by 5.5 foot long sand-filled PVC slug was submerged below the static water level (SWL) in the sand aquifer wells to displace a volume of water. The water level was then allowed to return to static conditions. Once the water level returned to the original depth, the slug was quickly removed. Following removal of the slug, the water level in the test well was periodically measured utilizing the Hermit 2000 data logger until it had recovered to at least 90% of the static level or until a one-hour monitoring interval had elapsed. The wells screened within the clay unit were tested by removing a slug of water from the well using a bailer and periodically measuring the depth to water using an IP for about 4 to 6 hours.

## 2.7 Groundwater Monitoring and Sampling

On July 14-17, 1995, September 11, 1995, and February 5-6, 1997, and February 26, 1997 groundwater levels in the monitoring wells were gauged using an electronic interface probe. This probe is capable of measuring the depth to water to within 0.01 feet. The depths to groundwater were used in conjunction with the TOC elevations to calculate the groundwater elevation at each location. The interface probe was thoroughly cleaned with a laboratory grade detergent and water solution, and rinsed with distilled water between each use. Monitoring well MW-133 was not gauged during the July 1995 visit since the broken well box made it appear the well was destroyed. Further investigation showed the integrity of the well had

not been breached and it was gauged during the September 1995 monitoring event. Monitoring well MW-150 was not gauged since it had been developed shortly prior to the sampling event and the water level in the well had not reached equilibrium with the formation. Well MW-200 was not gauged during the September visit due to excess bentonite in the well box. The bentonite was removed from the well box prior to the February 1997 event.

Groundwater samples were collected from all existing monitoring wells except MW-133 on July 14 and 17, 1995 for laboratory chemical analysis of VOCs by GTEL using EPA Method 8240. Groundwater samples were collected from the two new wells (MW-155 and MW-156) and MW-133 on September 11, 1995 for laboratory chemical analysis of VOCs by GTEL using EPA Method 8240. Groundwater samples were collected from all existing monitoring wells on February 5 and 6, 1997 for laboratory chemical analysis of VOCs by GTEL using EPA Method 8240. A second groundwater sample was collected from well MW-157 on February 26, 1997 to confirm the presence of TCE and to investigate tentatively identified compounds (TIC) reported during the previous sampling. Before sampling, a minimum of three well volumes of water were purged from each well using a clean disposable PVC bailer or a decontaminated purge pump. A water sample was then retrieved using a clean disposable bailer and carefully transferred from the bailer into 40 milliliter glass vials with zero headspace and preserved with HCL. The vials were then capped and stored on ice. Promptly after collection, all samples were sent by overnight express to GTEL for analysis under proper chain-of-custody procedures. Appropriate trip blanks, equipment blanks, and duplicate samples were also collected for analysis during the July 1995 and initial February 1997 sampling events. The disposable bailers were discarded after use on one well and the purge pump was thoroughly cleaned between sampling events using a laboratory grade detergent and distilled water rinse.

## 2.8 Stream Flow Measurements/Water Sampling

Stream flow measurements were obtained from three points in Little Eagle Creek on October 4, 1996 and February 10, 1997 utilizing an open channel water flow meter. The points are located upstream (ST-1), downstream (ST-3), and even (ST-2) with the site (Figure 3). Stream flow measurements were obtained by stretching a measuring tape across the creek channel from one bank to the other. Right and left bank measurements were measured using the tape. Water flow and depth were measured at evenly spaced intervals between the banks utilizing an open channel flow meter and a folding ruler or the measuring pole included with the flow meter. Stream water samples were collected from the three points (ST-1 through ST-3), near the mid-point of the channel, at the time of the measurements and sent by overnight courier to GTEL for analysis by EPA Method 8240. A trip blank, equipment blank, and duplicate sample were also collected and sent with the samples for analysis. Sampling equipment was thoroughly cleaned withalconox and a clean water rinse between sampling points.



### 3.0 PHYSICAL CHARACTERISTICS OF THE SITE

#### 3.1 Geology

The site area is underlain by the Wisconsin Age Undifferentiated Outwash Deposits and Holocene Age alluvium of Little Eagle Creek (Gray, 1989). Subjacent to this unit is the Devonian Age New Albany Shale which in turn is underlain by the Devonian limestones and dolomites of the Muscatatuck Group (Gray, et al, 1987).

Boring logs compiled during the current investigation indicate that the site area is underlain by unconsolidated materials to a depth of at least 65 feet bg. Three geologic cross sections were constructed to illustrate the site subsurface geology. Locations of the cross sections, A-A', B-B', and C-C' are depicted on Figure 5. The cross sections are presented on Figures 5A and 5B. Boring logs and well construction records for the recently installed wells, Geoprobe, and Hydropunch are provided in Appendix C. The logs indicate that the most surficial unit is a discontinuous silt and/or clay layer extending downward to an approximate elevation of 704 feet (10 feet below grade surface(bgs)). This surficial clay/silt layer is underlain by a sand layer with the bottom extent ranging from approximately 681 to 691 feet in elevation (24 to 34 feet bgs). A discontinuous clay/silt layer occurs within this sand layer in the western portion of the site with upper and lower extents at approximately 707 and 698 feet bgs in elevation, respectively. This sand layer is underlain by a silt/clay layer with the upper extent at approximately 691 to 681 feet in elevation. At it's thinnest known point this clay layer extends from approximately 690 to 682 feet in elevation (8 feet thick) at it's thickest known point this clay extends from 688 to 655 feet in elevation (33 feet thick). Another sand layer (discontinuous) is found beneath this lower clay layer with an upper boundary at approximately 682 feet in elevation and extending to at least approximately 663 feet in elevation (bottom extent of deepest boring). This sand layer was seen only in borings MW-200 and MW-301. A very thin (< 1 foot) sand seam was noted in MW-302 at an approximate elevation of 662 feet bgs.

#### 3.2 Hydrogeology

According to Meyer, et al, (1975) the aquifer system in Marion County consists of an underlying limestone aquifer, an unconfined glacial outwash aquifer, and a system of three discontinuous, confined sand and gravel aquifers (upper, middle, and lower). The upper confined aquifer does not exist west of the White



River (ie: the site location). These aquifers range in thickness from 0 to 40 feet and lie one above the other. They are generally separated from each other by varying thicknesses of silt and clay. The silt and clay layers act as semipervious confining beds (aquitards). Based on maps constructed by Meyer, et al, (1975), the middle and lower confined aquifers appear to exist beneath the Plant 10 site. In this area, the top of the middle confined aquifer (i.e. sand and gravel unit) ranges in elevation from approximately 680 to 700 feet (measured thickness of 7-12 feet) while the top of the lower confined aquifer (i.e. lower sand and gravel unit) ranges in elevation from 660 to approximately 680 feet (measured thickness 17-26 feet).

Monitoring wells MW10-1, MW-132, MW-133, MW-135, MW-145 through MW-148, and MW-150 through MW-158 are assumed to be completed in the middle confined aquifer described by Meyer (1975).

Monitoring wells MW-201, MW-202, and MW-302 are assumed to be completed in the clay unit between the middle and lower confined aquifers, while MW-200 and MW-301 are assumed to be completed in the lower confined aquifer. The intermediary clay layer thickens towards the south-southwest (near MW-302) from approximately 8 feet thick to greater than 33 feet thick.

Groundwater occurs locally in the middle confined aquifer at elevations ranging from 698.92 to 703.75 feet based on the three gauging events in 1995 and 1997. Based on the absence of a confining layer, this unit is assumed to be under water table conditions locally. In the intermediary clay layer, groundwater occurs at elevations ranging from 689.10 to 700.68 feet. The groundwater elevation for MW-202 was originally 689.10 feet (July 14, 1995), however, the well had recently been developed and the water level in the well may not have reached equilibrium with the water level in the formation. In the lower confined aquifer, groundwater occurs at elevations ranging from 698.83 to 701.00 feet. Well gauging data are provided in Table 2.

Groundwater elevation data for wells completed in the middle confined aquifer indicate flow across the property generally towards Big Eagle Creek to the south. Figures 6A, 6B, and 6C are potentiometric surface maps for the July 14-17, 1995, September 11, 1995, and February 5-6, 1997 gauging events (respectively). Comparison of these three maps shows a similarity in flow pattern across the site. Insufficient well coverage is available to determine groundwater flow direction in the lower confined aquifer. Based on the relative location of (big) Eagle Creek groundwater flow in this unit is likely to the south.

A comparison of well and creek gauging data from February 26, 1997 indicated that groundwater flow was directed toward the creek (as above) and based on relative water elevations shallow groundwater was discharging into the creek.

Three well clusters are present in the study area. One cluster (A), composed of MW-153, MW-202, and MW-302, is located in the western portion of the site. A second cluster (B), composed of MW-150 and

MW-200, is located east of the plant building. A third cluster (C), composed of wells MW-151, MW-201, and MW-301, is located off-site to the southeast. Clusters A and C have wells completed in all three of the previously discussed units. Cluster B has wells in the middle confined and lower confined aquifers. A comparison of groundwater elevations in the three well clusters indicated a downward gradient in the western portion of the site and east of the plant. An upward gradient was observed offsite to the southeast.

Rising head permeability tests were conducted on wells completed in the middle confined (water table) aquifer, intermediary clay layer, and lower confined aquifer. To evaluate the hydraulic conductivity of the materials tested, the analytical method presented in Bouwer and Rice (1976) for unconfined aquifers was used. In this method, time versus water level data are plotted as semilog (time on linear x-axis and water level on log y-axis). A straight line is fit to the linear portion of the curve. Typically, the late-time data is nonlinear and is not used. Appendix D contains the Bouwer and Rice analytical solution, table of analysis parameters, method plots with best-fit lines, and the raw field data.

Table 3 summarizes the results of the slug test analysis used to estimate hydraulic conductivity of the shallow sandy aquifer, the intermediate silty-clay aquitard, and the lower sandy aquifer. Good repeatability was found for repeat tests within a single well as shown for MW-151, MW-154, MW-200, and MW-301.

Core samples were collected during installation of MW-151 and MW-301. A falling head permeability test was conducted on the (repacked) core samples to estimate the material hydraulic conductivity. This test measures the vertical hydraulic conductivity of the sample. The most reliable results are obtained from intact core samples. Less reliable results are obtained when the samples are a repacked. Cohesive soils (high clay content) generally remain intact while noncohesive soils (low clay content) typically do not remain intact and require repacking prior to testing. These test results are not used in calculating the average horizontal K value for each unit.

Vertical to horizontal K ratios generally range from 1:2 to 1:100 (Walton, 1988). The ratios 1:2, 1:10, 1:100 are considered representative of low, medium, and high degrees of anisotropy, respectively (Walton, 1988). Based on MW-151 testing, the ratio for the shallow materials is about 1:30 which is considered a medium degree of anisotropy. The ratio from MW-301 tests suggest no difference between vertical and horizontal K of the lower sand.

As shown in Table 4, average K values are found to be 137 feet/day for the upper water table aquifer, 0.012 feet/day for the middle silt-clay aquitard, and 9.1 feet/day for the lower confined/semiconfined aquifer. The lower aquifer at the site most likely is under confined to semi-confined conditions. Slug test results for MW-302 were not used to calculate the average aquitard

K because the well is completed across a thin sand seam that may not be representative of the aquitard as viewed on an average or site-wide scale.

## 4.0 RESULTS

### 4.1 Soil Analytical Results

#### 4.1.1 Surface Soils (0-2 feet)

Detectable results of field screening of soils with a PID/FID ranged from 1.3 parts per million by volume (ppmv) in GP-4 to 4.6 ppmv in GP-1 and GP-2. Soil vapor headspace readings are summarized in Table 5.

Surface soils were collected during the advancement of Geoprobe borings GP-1 through GP-6 for analysis of priority pollutant metals. Chromium, copper, lead, nickel, and zinc were found in all six samples. Chromium concentrations ranged from 5.5 milligrams per kilograms (mg/kg) in GP-1 to 1,600 mg/kg in GP-2. Copper concentrations ranged from 7.4 mg/kg in GP-5 to 510 mg/kg in GP-2. Lead concentrations ranged from 8.6 mg/kg in GP-6 to 940 mg/kg in GP-2. Nickel concentrations ranged from 7.7 mg/kg in GP-1 to 28 mg/kg in GP-2. Zinc concentrations ranged from 36 mg/kg in GP-5 to 880 mg/kg in GP-2. Beryllium was found only in GP-3 at a concentration of 0.61 mg/kg and Cadmium was found only in GP-2 at a concentration of 4.1 mg/kg.

#### 4.1.2 Vadose Zone (2-10 feet)

Detectable results of field screening of soils with a PID/FID ranged from 0.4 ppmv in MW-156 (3-5 feet) to greater than 1000 ppmv in MW-158 (8-10 feet). Soil vapor headspace readings are summarized in Table 5.

Laboratory analytical results for soil samples collected during this investigation indicated the presence of VOCs in 8 of the 11 vadose samples collected. A total of five VOCs were detected in the samples and included trichloroethene (TCE), vinyl chloride (VC), {cis-} and {trans} 1,2-dichloroethene ({cis} and {trans} 1,2-DCE), and tetrachloroethene (PCE). None of the samples contained all five compounds. The most frequently detected compounds were TCE (5 out of 11 samples) and {cis} 1,2-DCE (3 out of 11 samples). 1,2-DCE is a degradation product of TCE and its occurrence may be attributable to the decomposition of TCE over time.

Detectable TCE concentrations ranged from 41.0 micrograms per kilogram (ug/kg) in GP-6 (5-7 feet) to 12,000 ug/kg in GP-1 (5-7 feet). TCE concentrations were below detection limits in MW-154 (8-10 feet).



MW-157 (3-5 feet), MW-158 (8-10 feet), GP-2 (5-7 feet), GP-3 (5-7 feet), and HP-1 (3-5 feet). Detectable concentrations of cis-1,2-DCE ranged from 40 ug/kg in HP-1 (3-5 feet) to 2,700 ug/kg in GP-1 (5-7 feet). Cis-1,2-DCE was below detection limits in MW-152 (8-10 feet), MW-154 (8-10 feet), MW-157 (3-5 feet), MW-158 (8-10 feet), and GP-3 through GP-6 (5-7 feet). VC, another degradation product of TCE, was detected only in GP-1 (5-7 feet) and GP-3 (5-7 feet) at concentrations of 40 ug/kg and 12 ug/kg, respectively. {trans} 1,2 DCE was detected only in GP-1 (5-7 feet) at a concentration of 25 ug/kg, while PCE was detected only in HP-1 (3-5 feet) at a concentration of 17 ug/kg. Soil analytical results for compounds detected in wells and borings installed by Fluor Daniel GTI are summarized in Table 6. Laboratory analytical reports are provided in Appendix E. Analytical results for TCE, 1,2-DCE, and VC in the soil vadose zone for these borings and those advanced by previous consultants are provided on Figure 7.

#### 4.1.3 Saturated Zone (>10 feet)

Detectable results of field screening of soils with a PID/FID ranged from 0.2 parts per million by volume (ppmv) in MW-200 (38-40 feet) and MW-202 (23-25 feet) to 540 ppmv in MW-302 (48-50 feet). Soil vapor headspace readings are summarized in Table 5.

Laboratory analytical results for soil samples collected during this investigation indicated the presence of VOCs in 6 of the 13 saturated zone samples collected. The five VOCs detected in the vadose samples were also detected in the saturated zone samples. Again, none of the samples contained all five compounds. The most frequently detected compounds were TCE (5 out of 13 samples) and {cis} 1,2-DCE (4 out of 13 samples).

Detectable TCE concentrations ranged from 6.8 ug/kg in MW-202 (33-35 feet) to 8,300 ug/kg in MW-202 (13-15 feet). TCE concentrations were below detection limits in MW-152 (18-20 feet), MW-154 (18-20 feet), MW-155 (28-30 feet), MW-200 (48-50 feet), MW-201 (both samples), and MW-302 (both samples). Detectable concentrations of cis-1,2-DCE ranged from 33 ug/kg in MW-200 (13-15 feet) to 3,500 ug/kg in MW-155 (13-15 feet). Cis-1,2-DCE was below detection limits in MW-152 (18-20 feet), MW-154 (18-20 feet), MW-155 (28-30 feet), MW-156 (18-20), MW-200 (48-50 feet), MW-201 (38-40 feet), MW-202 (33-35 feet), and MW-302 (both samples). VC, another degradation product of TCE, was detected only in MW-155 (13-15 feet) and MW-202 (13-15 feet) at concentrations of 60 ug/kg and 24 ug/kg, respectively. {trans} 1,2 DCE was detected only in MW-201 (18-20 feet) at a concentration of 11 ug/kg. PCE was detected in MW-156 (18-20 feet) and MW-200 (13-15 feet) at concentrations of 14 ug/kg and 18 ug/kg, respectively. Soil analytical results for compounds detected in wells and borings installed by Fluor Daniel GTI are summarized in Table 6. Laboratory analytical reports are provided in Appendix E. Available data indicates that concentrations of 1,2-DCE, TCE, PCE, and VC all decrease with depth.

## 4.2 Groundwater Analytical Results

### 4.2.1 Monitoring Wells and Hydropunch

Laboratory analytical results for groundwater samples collected from monitoring wells and the Hydropunch during the current investigation indicated the presence of VOCs in 28 of the 41 samples collected. A total of six VOCs were detected in the groundwater samples and included TCE, {cis} and {trans} 1,2-DCE, VC, acetone, and 1,1-dichloroethane. Acetone was detected in one sample only at a concentration near the detection limit. Since acetone is a common laboratory contaminant and was detected in one sample only at a low concentration, it was not considered to be present in groundwater. None of the samples contained all of the detected VOCs compounds. As was the case in soil, the most frequently detected compounds were TCE (22 out of 41 samples) and {cis} 1,2-DCE (21 out of 41 samples). VC was detected in 7 of the 41 samples and only in MW-155 (3,400 ug/L) during the February 5-6, 1997 sampling event. The compounds 1,1-dichloroethane and {trans} 1,2-DCE were not detected in any samples during the February, 1997 sampling event.

No VOCs were detected above the detection limit in MW-135, MW-154, MW-158, MW-200 through MW-202, MW-301, the trip blank, and the equipment blank. Groundwater samples collected from the remainder of the wells all contained detectable VOC levels. Detectable TCE concentrations ranged from 5.4 ug/L in groundwater collected from well MW-153 to 15,000 ug/L in well MW-132. Detectable {cis} 1,2-DCE concentrations ranged from 5.3 ug/L in groundwater collected from MW-152 to 65,000 ug/L in MW-132. Concentrations of {trans} 1,2 DCE ranged from 5.9 ug/L in MW10-1 to 1,400 ug/L in MW-148. Detectable VC concentrations ranged from 12 ug/L in MW-145 to 3,400 ug/L in MW-155

Data collected from the well clusters indicate that VOCs concentrations in groundwater decrease with depth. Only MW-302 contained a detectable VOCs concentration. MW-302 contained cis-1,2-DCE at a concentration of 8.2 ug/L. Groundwater analytical results for compounds detected during the current investigation are summarized in Table 7. Analytical results for TCE, 1,2-DCE, and VC in groundwater for the monitoring wells are provided on Figures 8A and 8B. Laboratory groundwater analytical reports are presented in Appendix F.

Isoconcentration maps were constructed for TCE, 1,2-DCE, and VC concentrations in groundwater using the February, 1997 data (Figures 9, 10, and 11). These figures show two areas of elevated VOCs at Plant 10. The two areas are: 1) west of the building in the vicinity of MW-132 and; 2) southeast of the building in the vicinity of MW10-1.

Two groundwater samples were collected from MW-157 in February 1997. Both contained a detectable concentration of TCE. Levels of 60 ug/L and 100 ug/L were detected in the well on February 6 and



February 26, respectively. Both samples contained a detectable concentration of undetermined aliphatic petroleum hydrocarbons. The type and quantity of the hydrocarbons could not be determined. The source appears to be localized to the vicinity of the well and not the site.

Groundwater data collected during previous investigations were compared to recent data to evaluate trends in dissolved VOCs concentrations. Historical dissolved VOCs data are provided in Table 7. In general, most of the wells did not exhibit major changes in dissolved VOCs concentrations with time. Dissolved VOCs concentrations did increase in wells MW-132 and MW155. Detected concentrations decreased in wells MW-148, MW-153, and MW-156. Wells MW-132 and MW155 are located in the western potential source area. Well MW-148 is located downgradient of MW-132. MW-153 is located in the well cluster located southwest of the building and MW-156 is located offsite to the southeast.

#### 4.2.2 Little Eagle Creek Surface Water Sampling

Surface water samples were collected from Little Eagle Creek at ST-1, ST-2, and ST-3 on October 4, 1996 and February 10, 1997 for analysis of VOCs by EPA Method 8240. Two of the samples collected in October 1996 (midstream and downstream) contained a detectable VOC concentration. The midstream sample (ST-2) contained 17 ug/L cis-1,2-DCE and the downstream sample (ST-3) contained 14 ug/L cis-1,2-DCE. Both values are below the Federal M.C.L. for drinking water of 70 ug/L. None of the samples collected in February 1997 contained a detectable VOC concentration. A trip blank analyzed for the October 1996 sampling event contained 5 ug/L methylene chloride. The method blank for the sampling event contained 5.9 ug/L methylene chloride. A concentration of 8.3 ug/L methylene chloride was detected in an equipment blank for the February 1997 sampling event. The laboratory report indicated that methylene chloride is a common laboratory contaminant. Analytical results for TCE, 1,2-DCE, and VC in the surface water from the creek are provided on Figure 12. Laboratory analytical reports for Little Eagle Creek are presented on Table 7B and in Appendix B.

### 4.3 Aquifer-Stream Interaction

#### 4.3.1 Stream Flow

To estimate stream flow in Little Eagle Creek in the vicinity of the site, stream velocity and flow depth were measured on October 4, 1996 and February 10, 1997. An upstream (ST-1), midstream (ST-2), and downstream (ST-3) location were selected as shown on Figure 3. At each location, stream depth and velocity were recorded every 2 feet in a direction perpendicular to flow, from the north bank to the south bank. The raw field data are summarized in Appendix G. Total stream flow at each location was calculated using a midpoint method. Discharge in cubic feet per second (cfs) for each 2-foot section of the stream is summed up to provide the total stream flow. These calculations are shown in Appendix G.



Calculated stream flow is summarized in Table 8. Stream flow on October 4, 1996 was too low and the flow area too wide, so flow velocity could not be accurately measured at the upstream and downstream locations. As a result, these data were not used in any calculations. At midstream, flow depth was adequate and stream flow was calculated as 7.98 or 8 cfs. Stream flow on February 10, 1997 was sufficient to measure velocity at all locations. Stream flow was calculated as 20.88 cfs, 23.77 cfs, and 23.58 cfs for upstream, midstream, and downstream locations, respectively. This indicates the stream is gaining volume as it flows past the site.

The nearest gauging station is located about 1.2 miles upstream of the site at the West 16th Street bridge. Flow data at this location from 1965 to 1995 (Stewart, 1983) are summarized for October and February on Table 8. The data suggest that, on average, the stream flow is lower (11.1 cfs) in October compared to February (30.4 cfs). Site specific stream flow data supports this observation. This suggests that the gaging station can be used to describe general stream flow trends at the site but more site-specific data would be needed before actual gauging station discharge values could be used quantitatively.

#### 4.3.2 Chemical Mass Loading to Little Eagle Creek

In the western portion of the site, groundwater from the shallow water table aquifer discharges to Little Eagle Creek. The groundwater concentration just before entering the stream is based on a temporary well point (HP-1) that was installed near the streambank (see Figure 2). Groundwater from HP-1, as sampled and analyzed on October 4, 1996, was found to contain 3,900 ug/L of cis-1,2-DCE, 430 ug/L of TCE, and 500 ug/L of VC.

Stream samples were collected on October 4, 1996 and February 10, 1997 (Figure 12) at locations upstream, midstream, and downstream of the site. Two of the samples collected in October 1996 (midstream and downstream) contained a detectable VOCs concentration. The midstream sample (ST-2) contained 17 ug/L cis-1,2-DCE and the downstream sample (ST-3) contained 14 ug /L cis-1,2-DCE. Both values are below the Federal MCL for drinking water of 70 ug/L. None of the samples collected in February 1997 contained a detectable VOCs concentration. A trip blank analyzed for the October 1996 sampling event contained 5 ug/L methylene chloride. The method blank for the sampling event contained 5.9 ug/L methylene chloride. A concentration of 8.3 ug/L methylene chloride was detected in an equipment blank for the February 1997 sampling event. The laboratory report indicated that methylene chloride is a common laboratory contaminant.

Site-specific hydrogeologic and chemical data are used to develop a conceptual model of aquifer-stream interaction so that chemical mass loading to the stream can be estimated. The conceptual model consists of a shallow sandy water table aquifer in good communication with Little Eagle Creek, a gaining stream at the site. Since the aquifer is relatively thin (about 18 feet), all of the

shallow groundwater is assumed to discharge to the stream as illustrated in Figure 13. The creek is a local discharge area in contrast with Eagle Creek, located further to the southwest, which is the likely discharge area for the deeper aquifers at the site.

The water table contour maps shown in Figures 6A, 6B, and 6C suggest a gaining stream at the site with the shallow aquifer contributing to stream baseflow. Baseflow is the relatively constant (long-term) contribution of groundwater to streamflow. Storm runoff accounts for the large fluctuations (short-term) in streamflow that occur above the baseflow. Average aquifer thickness, based on well logs, is about 18 feet. With such a limited thickness, it is not unreasonable to assume that all of the shallow aquifer discharges to the stream.

Assumptions must be developed for the groundwater chemical concentration as it enters the stream and the dimensions of the chemical loading area (thickness and width). HP-1 was screened in the upper few feet of the aquifer and is conservatively assumed to represent the concentration of groundwater entering the stream. In reality, the concentrations along the chemical loading width would be expected to diminish in directions away from HP-1. If the chemical plume maps and groundwater contour maps are superimposed, flowlines can be drawn to show the width of streambank where chemical loading occurs is about 360 feet, as shown in Figure 14. The chemical loading width is taken as the average aquifer thickness of about 18 feet. Given the relatively thin aquifer thickness and that sources are located up to 300 feet or more upgradient, concentrations are assumed to be distributed throughout the aquifer thickness.

The final assumption concerns mixing in the stream. It is assumed that complete mixing occurs as the aquifer discharges to the stream. Given the small width (about 35 feet) of the stream and limited depth (<0.50 feet on October 4, 1996), this assumption is reasonable.

The following form of Darcy's law (Todd, 1980) is used to calculate the discharge from the shallow water table aquifer into the stream through the chemical discharge area.

$$Q = K I A$$

where  $Q$  = volumetric flux (ft<sup>3</sup>/d)

$K$  = hydraulic conductivity (ft/d)

$I$  = hydraulic gradient (ft/ft)

$A = W \times D$  = chemical loading area (ft<sup>2</sup>/d)

where  $W$  = chemical loading area width (ft)

$D$  = chemical loading area thickness (ft)





The following values were selected:

$K = 137 \text{ ft/d}$  Average K from slug test analysis for the shallow aquifer  
 $I = 0.005$  Calculated directly from site water level data  
 $W = 360 \text{ ft}$  Based on plume and groundwater contour maps  
 $D = 18 \text{ ft}$  Based on average aquifer thickness from well logs

Groundwater discharge to the stream is calculated as  $1.4 \times 10^{-4}$  cfs per foot of streambank or 0.05 cfs along the chemical loading area. Assuming that the discharging groundwater contains the chemical concentrations observed in HP-1, the resulting stream concentration can be estimated as follows (modified from Todd, 1989):

$$Q_t C_t = Q_s C_s + Q_a C_a$$

where  $Q_t$  = combined flow (cfs)  
 $C_t$  = combined concentration (ug/L)  
 $Q_s$  = stream flow (cfs)  
 $C_s$  = stream concentration (ug/L)  
 $Q_a$  = aquifer flow (cfs)  
 $C_a$  = aquifer concentration (ug/L)

Solving for the combined concentration  $C_t$  yields:

$$C_t = (Q_s C_s + Q_a C_a) / Q_t$$

Input data to this equation are as follows:

$Q_s = 8 \text{ cfs}$  (observed)  
 $C_s = 0.0 \text{ ug/L}$  (observed)  
 $Q_a = 0.050 \text{ cfs}$  (calculated)  
 $C_a = 3,900 \text{ ug/L cis-1,2-DCE, } 500 \text{ ug/L VC, and } 430 \text{ ug/L TCE}$  (observed)  
 $Q_t = Q_a + Q_s$  (calculated)

Assuming only the western plume is loading to the stream, conservative estimates of stream concentrations at low flow conditions are 25 ug/L, 3.2 ug/L, and 2.7 ug/L for cis-1,2-DCE, TCE, and VC, respectively. All values are below the MCLs for drinking water supplies. Estimated stream concentrations during higher flow (February) are significantly below the detection limit of 5 ug/L for cis-1,2-DCE, TCE, and VC.



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aquifer-stream interaction modeling were considered for evaluations of the surface waters. The two surface water sampling events were both recent and only three months apart to represent low and high flow stream conditions. For the purposes of the risk assessment for the site, it is assumed that the site will remain intact as it currently is (surface cover and on-site building structures), be used as an industrial property in the future, and will continue to use only the municipal water supply for all water uses on site. Deed restrictions may be necessary to ensure future site uses under this assumption. Several other general assumptions were made during this risk assessment. They are as follows:

- Since little on-site and no off-site surface soil data were collected as part of the current or historic data collection efforts and based on the nature of the site-related constituents of interest (COI) being mobile, susceptible to leaching and volatilization, the subsurface soil data were assumed to conservatively represent both surface (0-2 feet) and subsurface (below 2 feet) soil conditions. Soil vapor headspace readings, summarized in Table 5, support the assumption that the upper soil layers did not have the most significant readings. The highest soil vapor readings typically occurred in the interval 13 to 20 feet below surface, which is within the saturated soil zone. Two surface soil samples were collected by a previous consultant (O'Brien & Gere Engineers, 1994) and reported as having extremely low level concentrations of one site-related COI in one surface soil sample. It should be noted that although the analytical results of these two samples support the assumption that the subsurface soils represent worst-case surface soil conditions, they were collected in a relatively unimpacted area in the western half of the northern side of the plant property.
- COI intake pathways for each examined receptor follow the same pathways as used by IDEM in calculating the Tier II Cleanup Goals (IDEM, 1996). IDEM regulations (1996) require comparison of soil concentrations to the Maximum Upper Limit values for chemical classes to be "protective of other potential exposure pathways not evaluated in the calculation of health-based criteria". For VOCs, the total VOCs concentration in soil cannot exceed 1,000 mg/Kg. None of the soil samples collected had total VOCs concentrations exceeding 1,000 mg/Kg. For this risk assessment, other soil potential pathways, such as for dermal contact have been assumed to be subsumed by the soil incidental ingestion pathway risk estimates.
- As described in section 5.3, Domestic and Municipal Well Locations, downgradient wells due south of the facility are not likely to be impacted from the plume identified on site in the upper aquifer in the western portion of the property due to the fact that all indications are that the groundwater in this aquifer discharges to the Little Eagle Creek. Additionally, the nearest downgradient well to the south appears to be approximately one-quarter of a mile downgradient, based on the current well survey. Obviously with mixing and other attenuation factors, not only would the groundwater be unlikely to migrate to this receptor but the concentrations at



downgradient wells south of the site would be much lower than the concentrations immediately off site (which typically do not significantly exceed IDEM residential health-based criteria for groundwater). It is assumed for this assessment that the only receptor to the western plume in the upper aquifer is the Little Eagle Creek.

- Sample HP-1, which is a shallow Hydropunch groundwater sample collected in the previous sampling event a few feet from the Little Eagle Creek shoreline, is assumed to be an anomalous groundwater sample. Comparison of the HP-1 COI concentrations to groundwater sample concentrations from wells immediately upgradient show much lower upgradient concentrations. However, the COI concentrations in HP-1 were used as worst-case conditions for the aquifer-stream interaction modeling to determine whether COI in the upper aquifer are deleteriously impacting Little Eagle Creek. The aquifer-stream interaction discussions are presented in \_\_\_\_.
- The soils collected within or under the water table (approximately 10-12 feet bgs) will not be considered as part of the subsurface soil data set for direct contact soil exposures since given the relatively stable depth to groundwater in the area of this site, no realistic scenarios (including commercial or residential construction activities) would normally involve human contact with soils at or below this depth. The soils at or below the water table are considered to be impacted as the result of the impacted groundwater plumes in the same areas, particularly for off-site impacts detected. As evidence of this assumption, in most locations where soil samples were collected just within the water table, the groundwater concentrations are significantly higher than the correlating soil concentrations of the COIs.
- An unregistered private residential well was identified due east of the facility on North Olin Avenue in a door-to-door survey performed by the Marion County Health Department. The residential well was sampled by the county and site-related COI were all nondetect. The groundwater flow from the relatively well-defined plume identified on the southeast portion of the site appears to be directed towards the south-southeast. Therefore, this residential well is assumed not to be a potential receptor for direct contact of this groundwater plume.
- The most current toxicity values for cancer slope factors (CSFs) and reference doses (RfDs) used in the human health risk evaluations were obtained from US EPA sources including references from the Integrated Risk Information System (IRIS) on-line database.

Other assumptions that are specific yet minor in consequence will be presented as they become necessary and applicable.

As stated in Section 5.0, the typical first step in data evaluation under the IDEM three tiered approach is to compare chemicals detected in impacted environmental media to Tier I background levels. However, this comparison was not completed for VOCs because these compounds do not naturally occur in the environment and because there is no evidence that the soil, groundwater, or surface water impact are related to upgradient sources. For the metals results in surface and subsurface soils, a background comparison was possible. The surface and subsurface soil metals results are presented in Tables 6B and 1B, respectively. Since IDEM does not provide background levels for the Tier I evaluations, literature values for the State of Indiana (when available) were utilized from *Elements in North American Soils* (Dragun, 1991). A summary of literature background ranges utilized for Tier I comparisons are presented in Table 9. Comparison of metals concentrations to the Tier I background ranges reveal arsenic, barium, chromium, mercury, and silver subsurface soil results are within expected background. Similarly, beryllium and zinc in surface soil results are within expected background. Therefore, these potential COIs can be removed from further consideration in this risk assessment.

Chemical concentrations reported for subsurface soil and groundwater were compared to IDEM Tier II generic health-based cleanup goals in Sections 5.3.2 and 5.4.2. Tier II health-based cleanup goals are calculated based on human health risks using standard risk assessment exposure assumptions generally following EPA's procedures for calculating preliminary remediation goals (EPA, 1991a). The results of the Tier II Cleanup Goal comparisons were used to focus discussions of the analytical results. These same comparative results will be used below to help screen COIs for the risk assessment. IDEM does not provide health-based cleanup goals for all chemicals for ecological or human exposures for impacted surface waters. In particular, the state's surface water quality criteria (1993) does not have a criterion for the COI cis-1,2-dichloroethene. Therefore, literature or federal screening values were used, as appropriate, for ecological receptors. Standard risk calculations were performed to evaluate whether potential risks exist for residential exposures to impacted surface waters.

#### 5.1.1 Data Gaps

As described in Section 5.1, only limited surface soil data were obtained as part of the historical data collection efforts (O'Brien & Gere, 1994). As stated above, only two surface soil samples were collected in an area found to be relatively unimpacted in subsequent investigations. For this assessment, the subsurface soil conditions have been assumed to be the worst-case surface soil conditions. This is a potential data gap because the true surface soil conditions are uncertain. However, based on the current inactivity of the site, knowledge of the upper soil physical conditions and the soil vapor headspace readings, the assumption that the subsurface soils data represent the worst case of the surface soils appears to be conservative and valid.



Another potential data gap relates to the uncertainty of the removal action of soils impacted by asbestos. Soil particles containing asbestos if at the surface could become airborne as fugitive dust. The O'Brien & Gere report (1994) indicated that certain surface and subsurface soils in areas in the northwestern portion of the property where brake pads were discovered contained bulk asbestos up to 10% by volume. Insufficient documentation exists to determine whether the removal action completely eliminated this potential threat. A site walkover conducted by Fluor Daniel GTI and General Motors personnel on June 10, 1997 revealed the presence of a crushed drum near the surface containing what appeared to be pieces of brake pads. The drum was located near the western wall of the plant building north of the driveway. Further subsurface investigations (i.e. test pits) are planned for the area to determine the magnitude and extent of buried drum and asbestos occurrence in the northwestern portion of the site.

Other potential data gaps include: 1) the lack of sediment data from the Little Eagle Creek which is a possible impacted receptor considering its close proximity to the site and the presence of constituents in the Hydropunch groundwater sample collected near the shoreline and in two of the surface water samples during the low flow sampling event; 2) the lack of complete definition of the areal extent of COIs in groundwater off-site to the southeast (additional monitoring wells are planned to address this data gap); and 3) the lack of additional data collection to identify whether results obtained in HP-1 are anomalous, however, as stated previously, use of data from HP-1 is considered conservative.

Although the lack of sediment quality data have been identified as a potential data gap for this assessment, a qualitative statement regarding the potential hazards of impacted sediments to likely receptors can be made. Based on relatively high water solubilities and low octanol-water partitioning coefficients ( $K_{ow}$ ), volatile organic chemicals tend to be very mobile in water and tend not to sorb to particulate matter. Based on the fact that the most significant point of exposure to environmental receptors (human and ecological) for potentially impacted sediments would be via the migration of the chemical to the surface water (Little Eagle Creek) and that two samplings of the surface waters have shown relatively minor impact, the sediments are not likely themselves to be of environmental concern. Comparison of the surface water sample data with surface water quality benchmarks for protection of human consumption (Title 327, Article 2, Water Quality Standards) and for ecological receptors (Suter, 1996) has clearly shown minimal potential for adverse effect of surface waters to these potential receptors. Therefore, the sediment quality data gap should not be construed as being of concern.

Additional wells are planned to be installed to address the lack of complete delineation of COI's in the groundwater off-site to the southeast of the site. The wells will be installed south and east of MW-157.

The lack of additional groundwater data from HP-1 is not a concern for the following reasons: data collected from HP-1 may not be representative of VOC concentrations in groundwater in the shallow sand unit at that location. If concentrations are vertically stratified (decline with depth), sample HP-1 would



overestimate the average value since it was collected from near the surface. A sample collected from a well point screened over the entire interval would provide a more representative vertically-averaged value of VOC concentrations. However, the data from HP-1 should represent the worst case and therefore appears to be conservative and valid.

### 5.1.2 Vadose Zone Soils

A total of 21 historic and current on-site subsurface soil samples from various depths and 3 historic and current off-site subsurface soil samples from various depths were collected at the site in the vadose zone and analyzed for VOCs. This data set serves as the basis for the soil potential exposures assessment in this report. All soil VOCs data for detected constituents are presented in Tables 1 and 6 for historical and current collection efforts, respectively. As described above in Section 5.1, only subsurface soils from above the water table were considered for direct contact exposures in this risk assessment. Historic subsurface soils were analyzed for a variety of chemical parameters including VOCs, semivolatile organics (SVOCs), polychlorinated biphenyls (PCBs), various TPHs, select metals, and asbestos. All of these parameter groups, except for VOCs and metals, were eliminated from current sampling programs due to a lack of positive detections. Current subsurface soil samples were analyzed for VOCs and recent surface geoprobe samples were analyzed for metals as described in Section 5.3. Current and historic soil metals results are presented in Tables 6B and 1B, respectively. In order to appropriately assess human health risks for VOCs and metals impact to site-related soils, COIs that realistically contribute to potential quantitative risks must be selected.

For this assessment, there are four criteria in selecting final COIs. As stated in Section 4.0, all environmental samples were analyzed for a target list of VOCs by Method 8240 and select samples were analyzed for various metals. The final COIs were selected from this list of chemicals. Note that the historic soil VOCs data had results for total-1,2-dichloroethene while the current sample analyses reported results separately for the cis- and trans-1,2-dichloroethene isomers. For consistency, the current analytical data results for cis- and trans-1,2-dichloroethene were summed to make a uniform data set in the risk-based summary tables. Since most of the total-1,2-dichloroethene concentration was contributed by the cis-1,2-dichloroethene isomer, (as can be seen from comparing the cis and trans 1,2-dichloroethene isomer concentrations shown in the original sample results in Tables 1 and 6) all physical and toxicity constants for the total-1,2-dichloroethene results were based on cis-1,2-dichloroethene. Also note that the historic subsurface soil samples that were selected for the metals analysis were analyzed for the metals arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver and the current surface soil samples that were selected for metals analysis were analyzed for the metals beryllium, cadmium, chromium, copper, lead, nickel, and zinc. However, this is not of significant consequence since, as were evident below, all metals results were screened out from evaluation in the risk assessment.



Several of these metals results have already been eliminated from further evaluation since they were within expected background ranges from literature values.

The first criterion used for selecting final COIs was examining whether the compound was site-related. The VOCs methylene chloride was only detected in three on-site soil samples that were all collected and analyzed on the same day at low concentrations. Based on the fact that this VOCs is not related to historical site uses, is a common laboratory contaminant, and the similarly low detected results are indicative of typical GC/MS blank contamination, methylene chloride was removed as a COI.

The second criterion for selecting final COIs is its detection. If a target VOCs or metal is not detected, it should be removed from further consideration. Tables 1 and 6 edited the list of target VOCs to only those that were detected in at least one sample. Frequency and statistical summaries of the VOCs COIs retained thus far for on-site and off-site subsurface soils are presented in Tables 10 and 11, respectively. These summaries present the minimum and maximum detected concentrations, the location of the maximum detected concentration, the frequency of detection, the arithmetic mean, standard deviation, and the 95 percent upper confidence level (UCL) for each vadose zone soil VOCs COI retained for further evaluation. Note that the statistics presented for vinyl chloride in Table 10 do not include the unusually high detection limit value for soil sample SB-132. This value was removed from the soil data set in accordance with the EPA guidance document RAGS (1989a), Section 5.3.2. The original reported sample quantitation limit was 6,300 ug/kg when the maximum detected concentration in sample SB-150 was only 500 ug/kg and the next highest detected value was found in sample GP-1 at 40 ug/kg. Therefore, even the half-detection limit value was more than six times higher than the highest detected concentration. Based on that fact and that vinyl chloride was only detected in three of 21 vadose zone soil samples, this value was not utilized in calculating the arithmetic mean, standard deviation, or 95% UCL value presented in Table 10.

When re-organized into on-site and off-site vadose zone summary tables, the off-site list of COIs removed vinyl chloride, trichloroethene, toluene, and xylenes for lack of any off-site detections. Similarly, when considering only vadose zone on-site soils, the on-site COI toluene is removed for lack of detections. All metals above background were detected in at least one sample.

The third and fourth criteria for this assessment are based on prevalence and whether the compound was detected above the Tier II Cleanup Levels. Normal EPA convention uses a cutoff of five percent as a percentage of detection frequency for assessing whether to retain a COI based on prevalence. Tetrachloroethene and total xylenes were both detected in on-site vadose zone soil samples at a frequency of one in 21 (4.8%). Additionally, neither was detected above its respective Tier II Non-Residential Cleanup Levels. Total-1,2-dichloroethene concentrations in on-site soils were all below its associated Tier II Non-Residential Cleanup Levels and tetrachloroethene and total-1,2-dichloroethene





concentrations in off-site soils were all below its respective Tier II Cleanup Levels. Therefore, based on either or both of these criteria (low prevalences and detections are all below the Tier II Cleanup Levels), these VOCs were removed from the list of final COIs for on- and off-site soil exposures.

Trichloroethene was the most frequently detected VOCs on site (14 of 21 wells). However, even though one single trichloroethene detection in SB-132 exceeded the Tier II Non-Residential cleanup goal, the 95% UCL of the arithmetic mean concentration for trichloroethene in on-site vadose zone soils was below the Non-Residential Tier II subsurface soil cleanup goal of 25,730 ug/kg. Therefore, this COI was removed from the list of on-site soil COI.

Examination of all soil results for metals retained thus far reveal all on-site vadose zone soils are below their respective Non-Residential Tier II Cleanup Levels and all off-site vadose zone soils are below their respective Residential Tier II Cleanup Levels. Note that the metals copper and lead do not have IDEM Tier II screening concentrations. Copper is a ubiquitous metal with relatively low toxicity. The U.S. EPA Region V's *RCRA Permitting Branch Guidance: Data Quality Levels* (1994) provide a screening level of 2,900 mg/kg as a health-based criterion. All soil copper results are well below this screening criterion. Lead is also a ubiquitous metal. The EPA IRIS toxicity constants for lead exposures have been withdrawn. Currently, EPA does not have any recommended toxicity values with which to calculate health-based screening levels. The U.S. EPA Region V screening level (1994) is 500 mg/kg. Surface and subsurface soil statistics for lead are shown on Table 12. Even though one surface (current) and one subsurface (historic) soil sample have anomalously high concentrations of lead that exceed this screening level, there is not likely a significant health threat based on the facts that the average lead concentrations are well below this screening level and the arithmetic 95% UCL concentrations for lead in the surface and subsurface soils are within or approximate the 500 mg/kg screening level. Therefore, copper and lead, as well as the other metals can be removed from further consideration in this risk assessment.

Note that the surface and subsurface asbestos results reported by O'Brien & Gere (1994) are additionally represented in Table 12 along with the lead statistics for informational purposes since these data reflect a potential data gap on site. However, this assessment will not further examine the potential health threat associated with the unknown status of soils impacted with asbestos since this type of impact is not normally quantitatively evaluated in a human health threat risk assessment. Typically, when a potential health threat exists such as friable asbestos, it is usually removed and properly disposed. For this site, a removal action was taken to address asbestos impacted soils and waste brake pads found on site, but sufficient documentation does not exist to thoroughly determine whether the removal action removed all potential threat. A few brake pads were found in a crushed drum during the site walkover conducted by Fluor Daniel GTI and General Motors personnel on June 10, 1997.

After examining the data using the four screening criteria, the remaining COI for on-site subsurface soil exposure assessments is vinyl chloride. None of the off-site vadose zone soil potential COIs were retained for further evaluation. Therefore, no off-site direct contact soil exposures need to be assessed.

### 5.1.3 Groundwater

As stated above, the groundwater investigation at the site included laboratory analysis of groundwater samples to evaluate groundwater quality and to assess the extent and degree of potential groundwater impact potentially due to past site activities. Historical groundwater samples were collected and analyzed for the same variety of chemical groups including VOCs, SVOCs, PCBs, various TPHs, select metals, and asbestos. All chemical groups were nondetected other than VOCs. Subsequently, all current groundwater samples have been analyzed for VOCs only. A total of twenty-one groundwater samples were most recently collected and analyzed for VOCs in the first week of February 1997 as described in Section 4.4. The current and historical groundwater analytical results for detected VOCs for all on- and off-site wells are summarized in Table 7. One hydropunch groundwater sample (HP-1) was collected in September 1995. No additional sampling was attempted at HP-1. Thus, the results for HP-1 were taken from the previous sampling event. Also note that a groundwater sample from the most downgradient off-site well to the southeast (MW-157) was recollected and reanalyzed in late February 1997 because the vinyl chloride detection limit in the sample collected previously had been reported by the laboratory with a high detection limit due to sample interferences. The latter sample results were utilized in this assessment since the vinyl chloride detection limit met the practical quantitation limit (PQL) for the method and the trichloroethene concentration in this sample was the highest measured off-site to the southeast. As with subsurface soils, the same four criteria were evaluated to select final COIs for groundwater.

The VOCs presented for groundwater in Table 7 are the list of detected target compounds which satisfies the first criterion for selecting final COIs. Acetone, a common laboratory blank contaminant, had been detected in one of 19 samples collected in the previous sampling event at a concentration well below its Tier II Cleanup Level for both residential and non-residential exposures. Therefore, based on the first, third, and fourth criteria defined above, acetone was removed as a COI. Acetone was not detected in any current groundwater samples.

A frequency summary of the COIs retained thus far for the combined on-site and off-site groundwater are presented in Table 13. This summary presents the minimum and maximum detected concentrations, the location of the maximum detected concentration, and the frequency of detections for each COI retained for further evaluation. Note that trans-1,2-dichloroethene was not included in this table since current groundwater results had no positive detections for trans-1,2-dichloroethene.

The target VOCs 1,1-dichloroethane was not detected in any of the twenty-three current groundwater samples. Thus, based on the second and third criteria used for selecting COIs of detection and prevalence, 1,1-dichloroethane was removed from further consideration. After examining the data using the four screening criteria, the remaining COIs for the on-site and off-site groundwater are vinyl chloride, total-1,2-dichloroethene, and trichloroethene.

#### 5.1.4 Surface Water

Three surface water locations were sampled in October 1996 and February 1997 and were analyzed for VOCs as discussed in Section 4.2.2. Results of the three COIs retained for groundwater evaluations are presented in Figure 12. The October 1996 sampling event represented low flow conditions and the February 1997 sampling represented high flow conditions. The only COI detected in the two events was cis-1,2-dichloroethene. Cis-1,2-dichloroethene was not detected in the upgradient station ST-1. The two surface water stations adjacent to the two on-site plumes revealed positive detections of cis-1,2-dichloroethene in the low flow sampling event only with a maximum detected concentration of 17 ug/L. No other VOCs were detected in either sampling event.

The detections of cis-1,2-dichloroethene in these locations support the assumption that the groundwater in the upper aquifer is discharging to the Little Eagle Creek. In order to evaluate whether the detections of cis-1,2-dichloroethene would be the expected worst-case surface water conditions in the future, an aquifer-stream interaction modeling was performed. Results of this modeling are presented in Section \_\_\_\_\_. Utilizing the anomalously high results in hydropunch sample HP-1 as a continuous source concentrations along the stream the model predicted that the detections found for cis-1,2-dichloroethene represent the worst-case conditions for current and future exposures. The model predicted at low flow that concentrations of vinyl chloride and trichloroethene would be below the reporting limits for the analytical method utilized. This conclusion is supported by the analytical results from two sampling events.

Literature screening values were obtained for evaluation of potential ecological receptors for cis-1,2-dichloroethene. The U.S. EPA's *Quality Criteria for Water* 1986 (1987) lists an acute lowest observed effect level (LOEL) for dichloroethenes for freshwater organisms at 11,600 ug/L. The *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Freshwater Biota* (Suter, 1996) cites a Lowest Chronic Value extrapolated from an LC50 using regression at 14,680 ug/L and a Lowest Chronic Ambient Water quality criterion for fish at 9,538 ug/L. These references demonstrate that the low detections of cis-1,2-dichloroethene are almost three orders-of-magnitude less than the lowest of these literature screening values and thus, demonstrate the insignificant potential threat to ecological receptors of cis-1,2-dichloroethene in the surface waters at the site.



Since IDEM does not provide Tier II Cleanup Levels for human exposures to surface waters potentially impacted by cis-1,2-dichloroethene, a site -specific Tier III evaluation of risks associated with the most realistic exposure pathway for nearby off-site residents was performed to ascertain whether the cis-1,2-dichloroethene detections potentially posed a threat to human receptors. The only COI for surface water risk assessment evaluations is cis-1,2-dichloroethene.

#### 5.1.5 Uncertainties Associated with Data Collection and Evaluation

Uncertainties associated with the data collection and evaluation activities include:

- the use of subsurface soil conditions to demonstrate the worst case surface soil conditions;
- the slight uncertainty associated with using soil data that were reported on a wet weight basis rather than dry weight corrected (concentration would go up by 10-20% in dry weight);
- the use of maximum groundwater results from an off-site location adjacent to the site to represent worst-case point exposure conditions for residential exposures when complete off-site delineation has not yet been completed; and
- the number of samples collected per medium and sampling locations selected to identify and define extent of impact.

Uncertainty associated with the data are also limited by the fact that the chemicals detected in soil and groundwater at the site focus on the most impacted areas. Therefore, these biased samples likely overestimate the potential risk at the GM Allison Plant No. 10 site.

#### 5.2 Tier III Site-Specific Risk Assessment

The final COIs for soil, groundwater, and surface water that were retained will be carried through to the Tier III site-specific risk assessment. The purpose of this section is to identify realistic exposure scenarios for the site so that the Tier III site-specific human health risk assessment can be quantitatively evaluated. Both current and reasonably foreseeable future land uses of the site are considered in developing site-specific exposure scenarios. Per IDEM regulations, the risk assessment and subsequent cleanup goals, if necessary, are based on resource uses for the site and surrounding area. Tier III assessments also utilize the reasonable maximum exposures expected to occur under both current and potential future use conditions of areas impacted by a release or imminent threat of a release of hazardous substances (IDEM, 1996). These regulations and directives from IDEM substantially follow EPA guidance for performing risk assessments under the Risk Assessment Guidance for Superfund (RAGS) Parts A and B (1989a; 1991a; and 1991b).



IDEM and EPA have developed standardized methodology for quantitatively evaluating risk for soil, groundwater, and surface water exposures. This begins with the determination of probable land uses of the site and potential receptors that would be exposed to COIs in the on- and off-site soils and groundwater and the off-site surface water (IDEM, 1996).

#### 5.2.1 Land Use

Basic physical site characteristics are discussed in Section 2.0 while basic site geology and hydrogeology characteristics are discussed in Section 5.0. The property is zoned industrial and is currently being used as a automotive parts warehouse. Land use in the surrounding area of the site is mixed use with zoning predominantly residential, general business and industrial. The properties immediately surrounding the site are:

- North: A city park
- East: Residential properties
- South: Wooded area and Little Eagle Creek
- West: Holt Road and Allison Transmission

A site vicinity map is presented in Figure 3.

As stated in Section 5.1, a basic assumption of this risk assessment is that the on-site property's reasonably foreseeable future land use is that it will continue the same as the current or historic use as a commercial/industrial property. Since the facility is supplied with a municipal water supply it has been assumed that no potential uses of on-site groundwater will occur in the future.

As discussed in Section 5.3, a domestic and municipal well location survey was completed by plotting all county registered wells that are within a one mile radius of the property. The domestic/municipal well location map is presented in Figure 4. The nearest downgradient well to the site is approximately one-quarter of a mile due south of the site. As noted above, a residential well has been identified due east of the facility but is cross gradient of the on-site plumes, is not currently impacted, and is not expected to be impacted in the future. Analytical results of water samples from on-site wells in the northeast corner of the site, which would be more upgradient of this off-site residential well do not indicate detectable VOC concentrations in any of the four groundwater sampling events to date. VOCs occurrence in shallow groundwater likely discharges into Little Eagle Creek. Therefore, it is unlikely that dissolved VOCs extend south of the stream to the south.



Since a public water supply is available to area residences, it is unlikely that wells to the southeast of the site are utilized for household use, including consumption. However, there are no ordinances in Indianapolis prohibiting the installation of a potable water supply well even where a municipal supply is available. It should be noted that MCHD personnel Paul Gilson indicated during a recent discussion with Fluor Daniel GTI that they plan to develop a program in the near future to deny well installation permits in areas where contamination is known and public water supply is available. He also stated that they were considering the use of the Allison Plant 10 site as a pilot case for this program. For conservatism, it is assumed that the groundwater immediately off-site may be used in the future as a potable water source and that the worst case intake by affected residential receptors would be the maximum off-site VOCs concentrations.

### 5.2.2 Potential Human Receptors

Potential human receptors who are likely to be present at the site or in the surrounding environment, and who, as a result could be exposed to COIs at the site, are identified based on the current and future land uses of the site (assumed to be industrial) and surrounding area (assumed to be mixed use including residential and industrial with the most sensitive receptors being residents). In addition, Fluor Daniel GTI assumed that the site surface will remain intact. Currently, it is covered by asphalt, concrete, and a relatively uninterrupted vegetative cover. Based on the assumed land uses specified in Section 5.4.1, the potential receptors are:

- on-site worker
- on-site construction worker
- off-site child resident
- off-site adolescent resident
- off-site adult resident

Groundwater scenarios for residents will not be separately evaluated for child and adult residents in accordance with scenarios evaluated by IDEM for calculation of Tier II Cleanup Goals (IDEM, 1996). The off-site adolescent resident receptor will only be specifically examined for the recreational use of the Little Eagle Creek. Additionally, residential receptors are the only receptors examined off-site for two reasons:

- Based on potential durations and frequencies of exposure, off-site residents who live nearby the property are the most sensitive of any reasonably expected future or current off-site receptor groups; and



- Because off-site data are limited to locations immediately adjacent to the facility property line, off-site extent of impact is uncertain and worst case exposures of COI concentrations from these adjacent sample locations are assumed.

On-site trespassers have not been included because the property is securely fenced and potential trespassers are extremely unlikely to regularly contact on-site surface soils based on the current and assumed future surface cover that is in place. Additionally, on-site trespassers would be even less likely to ever come into contact with on-site subsurface soils or groundwater. Therefore, the on-site trespasser receptor who may normally be evaluated for this type of risk assessment will not be examined.

### 5.2.3 Exposure Pathways

#### 5.2.3.1 Soils

The following pathways are considered significant for surface and subsurface soils for on-site non-residential uses per IDEM guidance:

- incidental ingestion of soil
- inhalation of volatiles and soil particulates

Therefore, these exposure pathways for soils were considered the most significant when considering the site-specific receptors. As stated in Section 5.1, other exposure pathways, including the dermal route, are not evaluated, but are considered by applying IDEM's maximum upper limits (IDEM 1996) for each chemical class.

Receptors may contact site-related COIs in the following ways based on site conditions.

- An on-site worker at the site may come into contact with surface soil during daily work activities under current conditions because the site is not entirely paved. In the future, this exposure pathway is uncertain. The surface soil exposure routes would be incidental ingestion of soil and inhalation of volatile vapors and soil particulates. The potential also exists for an on-site worker to come into contact with subsurface soils under very limited conditions if the worker's responsibilities included facility maintenance. This type of exposure would be expected to be infrequent and last for a short time period. The exposure routes would also include incidental ingestion of soil and inhalation of volatile vapors and soil particulates.
- An on-site construction or utility worker at the site may come into contact with surface and subsurface soil during routine utility maintenance activities or future construction activities involving excavation. The exposure routes would be the same as for the on-site worker except

the construction or utility worker would be expected to be exposed for a much shorter duration to both surface and subsurface soil.

#### 5.2.3.2 Groundwater

The following pathways are considered the most significant for off-site residential groundwater uses:

- ingestion of groundwater used as a potable water source
- inhalation of volatiles from the groundwater used as a potable water source
- dermal contact with groundwater used as a potable water source
- inhalation of volatilized vapors intruding into residences from impacted groundwater beneath the residence's foundation or basement

Therefore, these exposure pathways for groundwater were considered the most significant when evaluating the site-specific receptors. On-site non-residential groundwater exposure pathways will not be further evaluated in this risk assessment based on the following rationale:

- An on-site worker at the site is very unlikely to ingest groundwater during daily work activities since well water has not previously been used nor will likely be used as a potable water source on-site. The facility is connected to the local public water supply and it is unlikely that condition will change in the future use of the site. A deed restriction may be necessary to guarantee this assumption remains intact in the future. The groundwater exposure route of inhalation of volatile vapors from and dermal contact with on-site groundwater is unlikely for on-site workers because the typical pathway for this exposure route is via showering or bathing using well water. Inhalation of volatilized vapors intruding into the on-site building is unlikely since the plumes on site are not beneath the building, appear to be moving away from the building, the indoor air volume as a warehouse type of structure would allow significant dilution of potentially intruding vapors, and the indoor air exchange rate with large warehouse doors would tend to be quite high (which would allow for frequent fresh air replenishment).
- An on-site construction worker at the site is also unlikely to ingest groundwater during future construction activities since well water has not previously been used nor will likely be used as a potable water source on-site. It is unlikely that a future on-site construction worker would physically come into direct contact with groundwater on-site during excavation activities because the typical depth to groundwater is 11 to 13 feet below the surface. This is deeper than most depths required under normal construction activities. The on-site construction worker would also unlikely be exposed to routes other than ingestion for the same reason as for on-site workers.





### 5.2.3.3 Surface Water

The only single pathway that could potentially be considered significant for surface water exposures considering the stream size and nature would be for an off-site resident's use of the creek for recreational purposes. Normally, adolescent residents would be the most realistic receptor for this type of stream use. Young children and adults are unlikely to use the stream in this capacity. Other potential exposure pathways such as ingestion of wildlife that may exist in the stream is extremely unlikely because of the physical setting of the stream such as size, ability to support biota, and accessibility by potential receptors.

### 5.2.4 Quantify Exposure Pathways

For assessment of groundwater direct contact exposure risks (ingestion, inhalation, and dermal contact with groundwater used as a potable water source), the only receptor retained for evaluation was the off-site resident. Since the State of Indiana Tier II Residential Goals were developed with the specific intention to be protective of residential exposures to impacted groundwater, site specific direct contact groundwater exposure human health risks will not be quantitatively estimated herein. Instead, groundwater concentrations were evaluated by comparing each COI to its respective Tier II Residential Goal. Each groundwater COI for this baseline risk assessment has a Tier II Residential Goal. These values are typically their federal Maximum Contaminant Levels (MCLs). However, the indirect exposure route of inhalation of volatilized vapors from groundwater intruding into an off-site resident's basement were quantitatively evaluated to ascertain whether this exposure route is significant.

The majority of exposure input parameters for the soil, groundwater, and surface water exposure risk assessments for pathways not evaluated solely by direct comparison to Tier II cleanup goals were taken directly from IDEM's Intake Assumption tables for calculation of the Tier II Cleanup Goals, as applicable (IDEM 1996). Site specific exposure parameter values were substituted for IDEM's default values for a few intake parameters. In general, there are three categories of variables that are used in these equations:

- COI-related variables -- absorption factors, soil/air and groundwater/air volatilization factors, and particulate emission factors;
- variables that describe the exposed population -- intake rate and body weight; and
- assessment-determined variables -- exposure frequency and duration; and averaging times.

The variables and associated values used for soil, groundwater, and surface water exposure pathway-receptor combinations evaluated are presented on their respective quantitative risk assessment and



related calculation tables (Tables 14 through 20). The variables and values for the identified exposure pathways for each exposure scenario are described below.

#### 5.2.4.1 COI-Related Variables.

**Absorption Factors:** An absorption factor (AB) defines the fraction of chemical which is expected to be absorbed through the body based on the route of exposure. This factor depends on the chemical and physical properties of the specific compound. Usually complete absorption (100%) is assumed for chemicals when exposure occurs via inhalation or ingestion (EPA, 1989a; 1989b). Assuming total absorption is the most health protective as there are few compound-specific studies in humans available in the literature that can be used to estimate absorption into the body. Therefore, for all identified receptors 100% absorption was assumed for the ingestion and inhalation exposure pathways. As such, this variable does not appear in any of the formulae for risk calculations as it would have no difference in impact to the result.

The dermal permeability constant (PC) defines the rate a chemical in water will absorb into the body based on dermal contact. This factor is also dependent on the chemical and physical properties of the specific compound. However, PC reference values for the COIs selected in this assessment could not be individually determined. EPA guidance (1989a) recommends using a default PC value for water as a substitute. This PC value is  $8.4 \times 10^{-4}$  cm/hour.

**Volatilization Factor:** The volatilization factor ( $VF_{soil}$ ) relates the concentrations found in soils to the amount of volatile vapor that can be expected to be released into the ambient air through volatilization. One basic assumption for this model is that the formula is designed on the assumption that the source is homogenous, continuous, and constant without any impediments or retardation of the vapors volatilizing from the soil. The  $VF_{wesp}$  relates the concentrations found in groundwater beneath the surface through the soil and intruding into an enclosed space such as a basement through a foundation or floor crack. These factors are chemical-specific and relate to individual physical constants such as partitioning coefficients, Henry's Law constants, and chemical diffusivities. The formula for calculating site-specific VFs for soils for all COIs is found in IDEM Tier II Cleanup Goal guidance (IDEM 1996). The only values used in the formula for calculating soil VFs that were not IDEM default values or literature-based physical values were the length of the on-site area affected and the total surface area which were both estimated. The literature reference for all chemical-specific physical inputs, except for  $K_{oc}$ , was from the U.S. EPA's *Technical Background Document for Soil Screening Guidance* (1994). A  $K_{oc}$  value was estimated for vinyl chloride using Equation 4-5 from the *Handbook of Chemical Property Estimation Methods* (Lyman et al. 1993). Table 14 is a summary of all parameters and values used in calculating the site-specific VFs for the two remaining vadose zone soil COIs. The  $VF_{soil}$  value was 108 m<sup>3</sup>/Kg for vinyl chloride.

The formula for calculating a site-specific  $VF_{wesp}$  for the only groundwater COI detected above its respective Residential Tier II Cleanup Level in an off-site well (trichloroethene) is from the Johnson and Ettinger model (1991) as represented in the American Society of Testing Materials (ASTM) *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (RBCA) (E1739-95) (1995). The only values used in the formula for calculating the  $VF_{wesp}$  that were site-specific were values related to the depth of water below the point of intrusion. The average depth to groundwater in the three off-site wells to the southeast was 11.4 feet. Assuming the affected residence has a basement with a typical construction would leave approximately six feet below the surface to the basement floor. Therefore, the approximate assumed depth below a basement to the groundwater in the upper aquifer off-site is five feet. Calculation of the site-specific  $VF_{wesp}$  is presented on Table 15 along with the formula and all parameters and values used. The calculated  $VF_{wesp}$  for trichloroethene was  $6.31 \times 10^{-3}$  mg/m<sup>3</sup>/mg/L air-to-water.

**Particulate Emission Factor:** The particulate emission factor (PEF) relates the concentration of a COI in soil with the concentration of respirable particles (PM<sub>10</sub>) in the air due to fugitive dust emissions from the site. This relationship is derived by Cowherd (1985) for a rapid assessment procedure applicable to a typical hazardous waste site where the surface contamination provides a relatively continuous and constant potential for emission. Particulates of fugitive dust emissions from sites are due to wind erosion and, therefore, depend on the erodibility of the surface material. EPA has suggested a default PEF of  $4.63 \times 10^9$  m<sup>3</sup>/kg (EPA, 1991a). A site-specific PEF was calculated using the formula presented in IDEM's Tier II Cleanup Goal guidance (IDEM 1996). Calculation of the site-specific PEF is also presented on Table 14 along with the formula and all parameters and values used. The only non-default or non-lookup parameter values were for vegetative cover and threshold wind speed which were both estimated. The site-specific PEF calculated was  $1.7 \times 10^{12}$  m<sup>3</sup>/Kg.

#### 5.2.4.2 Exposed Population Variables.

Exposure population variables are those assumptions associated with each identified receptor. These variables include body weight and intake rates for specific routes of exposure.

**Body Weight:** The body weight (BW) was assumed to be 70 kilograms (kg) for all adult receptors in accordance with EPA guidelines (EPA 1989b) and is the IDEM default value (1996). This value represents the average body weight for male and female adults. For an adolescent resident, the body weight used was the average weight for teenagers male and female for the age categories 12-15 and 15-18, as presented in the U.S. EPA's RAGS (1989b).

**Soil Ingestion Rate:** The ingestion rate ( $IR_{soil}$ ) used is believed to represent an upper-bound value for soil ingestion. The IDEM default  $IR_{soil}$  values were used for soil exposure calculations. Thus, a value of 50 mg/day was used as the default  $IR_{soil}$  for adults in the "typical" workplace for the on-site worker. For the



on-site construction worker an  $IR_{soil}$  of 100 mg/day was used as construction activities involve a more significant disturbance of soil.

**Inhalation Rate:** Inhalation rates ( $IR_{air}$ ) of 15.5 m<sup>3</sup>/day and 24 m<sup>3</sup>/day were calculated using EPA (1989b) data for a site-specific industrial soil exposure for an on-site worker and an on-site construction worker. These values were calculated by combining reasonable worst-case inhalation rates for indoor and outdoor activities estimated in the EPA's Exposure Factors Handbook (1989b). EPA guidance lists the reasonable worst-case outdoor inhalation rate as 3.0 m<sup>3</sup>/hour and the reasonable worst-case indoor inhalation rate as 0.89 m<sup>3</sup>/hour. To calculate site-specific inhalation rates for on-site workers and construction workers, it was assumed an on-site worker would have a maximum split of indoor / outdoor activities as 50 percent for each on a routine basis and a construction worker would have a maximum of 100 percent outdoors. Therefore, based on an 8 hour workday, an on-site worker's estimated total inhalation rate while on-site would be approximately 15.5 m<sup>3</sup>/day and an on-site construction worker's estimated total inhalation rate while on-site would be approximately 24 m<sup>3</sup>/day.

The inhalation rate for an off-site resident's indoor exposure to volatilized vapors is the EPA and IDEM default value for an adult receptor of 15 m<sup>3</sup>/day.

**Contact Rate:** The EPA default (1989a) contact rate (ingestion) for water during swimming activities of 50 mL/hour was utilized for the surface water exposure.

#### 5.2.4.3 Exposure Scenario Variables.

Exposure scenario variables are those assumptions that describe the duration and time of exposure for identified exposure pathways.

**Exposure Frequency, Duration and Time:** Exposure frequency (EF) is the number of times a receptor is expected to be exposed to a COI usually expressed as days/year. The exposure duration (ED) is the amount of time a receptor is assumed to be exposed. For the most part, IDEM and EPA recommend that upper-bound values be selected for these exposure variables as part of the reasonably maximum exposed receptor.

Exposure frequency and duration for an on-site worker recommended by EPA and IDEM were values of 250 days per year for 25 years. These time factors are based on an 8-hour workday (ET) and assume a work period of 5 days per week for 50 weeks based on a two-week vacation (EPA, 1991b). For surface and subsurface soil exposures, the 250 days per year EF value was adjusted since it could be assumed the majority of the work at the property would be inside and since the frequency does not account for inclement weather. The ground is estimated to be snow covered or frozen approximately five months of the year in Indiana. For the shorter term that an on-site worker could normally be exposed to surface and

subsurface soils considering weather conditions and the number of normal working days during fair weather conditions, an EF of 120 days/year was used for both surface and subsurface soil exposures. The ED remained 25 years for soil exposures for this receptor for surface exposures. Since the on-site worker would be expected not to be routinely exposed to subsurface soils except during construction or maintenance that disturb the surface cover, the ED for subsurface soil exposures for an on-site worker was estimated as a maximum of 2 years for multiple surface disturbances during an employee's duration of employment.

The on-site construction worker was assumed to work 8-hour work shifts 5 days per week for a six-month time frame. This accounts for any type of construction activities being completed for the site under both current and future land use. This results in an EF of 120 days/year with an ED of 0.5 years for soil exposure pathways.

The off-site resident exposures are based on the upper bound maximum duration that a resident would be expected to live in one residence, which is 30 years. This is both the EPA and IDEM recommended value for a resident's ED. EPA and IDEM recommend using an EF of 350 days/year for all residential exposures. This value was used for the groundwater-to-indoor air residential exposure pathway examined.

The EF and ED for an adolescent resident's exposure to the Little Eagle Creek for recreational uses is based on the assumption of two events a week during an approximate 12 week summer during prime adolescent ages of 12 to 18 years old for an ED of approximately 25 events/year and an ED of 6 years. An estimated 2 hour ET duration per event was assumed.

**Averaging Time:** Averaging time (AT) is the total amount of time a receptor is exposed to a COI. For carcinogens the AT is 25,550 days. This is based on the assumption that an individual has an average lifetime of 70 years and is exposed 365 days/year. For noncarcinogenic endpoints, the AT is based on the specific ED in years for each pathway multiplied by 365 days/year.

#### 5.2.5 Uncertainties Associated with Exposure Assessment

The most significant uncertainty associated with the exposure assessment that influences the calculation of site-specific human health risks is the accuracy in characterizing land uses. It is assumed that future land use of the site will remain industrial. Although the property could conceivably be redeveloped in the future for residential use, the assumptions regarding land and groundwater use at this site carry a high degree of confidence because they are based upon multiple factors that strongly support continued industrial use into the foreseeable future (e.g., zoning, historical use and current building trends). In



addition, as a requirement of the IDEM VCP, a deed restriction for this project site may need to be developed to limit future use of the property to industrial use and to restrict future on-site groundwater use.

Parameters such as inhalation and ingestion rates, assuming 100% absorption, exposure duration and frequency are high-end estimates to conservatively calculate health-based risks. Other exposure parameters such as body weight are average values following IDEM and EPA recommendations that a range of upper-bound and average values should be used to estimate exposure. Thus, although uncertainty is present in the exposure parameters, the parameters were selected such that resulting exposures are most likely overestimated to be protective of human health.

One additional uncertainty in the exposure assessment deals with the use of simple chemical transport/migration models. Typically, these models have basic assumptions that perfect physical conditions will be in effect, that the sources are continuous, constant, homogeneous, and nondegrading or retarding from the source to the final point of intake by the receptor. However, under realistic conditions, all of these assumptions being true is highly unlikely. These simple and rapid models tend to also overestimate transport mechanisms' efficiencies since it is unlikely that all of these conditions can be simultaneously true.

#### 5.2.6 Toxicity Assessment

As part of performing the Tier III risk assessment, a toxicity assessment is required. The toxicity assessment involves evaluating the dose-response relationships for the COIs. This includes an assessment of the types of health effects associated with the exposure to site-related COIs and the relationship between the magnitude of the exposure and the adverse effects. The toxicity assessment determines the quantitative relationship between the dose of a COI and the incidence of adverse health effects. The end result of the toxicity assessment is the derivation of toxicity values which are used to calculate Tier III human health risks.

The EPA has developed two sets of toxicity values that provide quantitative estimates of the potency of chemicals and resultant toxic effects. These toxicity values are known as reference doses (RfDs) and cancer slope factors (CSFs). RfDs are used to evaluate the noncarcinogenic toxic effects while CSFs are used to evaluate the carcinogenic effects of COIs.

##### 5.2.6.1 Toxicity Values for Noncarcinogenic Effects

Noncarcinogenic effects, such as organ damage or reproductive effects, are evaluated by reference doses (RfDs). The reference dose for an individual COI is expressed in units of milligrams per kilogram per day (mg/kg-day). The RfD is usually based on the relationship between the dose of a COI and the occurrence of systemic toxic effects in either experimental laboratory animals or humans. The methodology for

deriving a reference dose inherently assumes that there is a threshold intake rate below which no adverse effect will occur. Generally, a No Observed Adverse Effect Level (NOAEL) is divided by a safety factor to obtain a RfD that is intended to provide a benchmark for the daily dose to which humans, including sensitive populations such as children, may be subjected without an appreciable risk of deleterious effects during a lifetime (assumed to be 70 years).

Safety factors are factors of 10 that account for interspecies variation and sensitive human populations. These include variation in the general population (intended to protect sensitive subpopulations such as children and the elderly) and extrapolation from animal data to humans. Additional factors of 10 are included in the safety factor if the RfD is based on the lowest observed adverse effect level (LOAEL) instead of the NOAEL, or an experiment that includes a less-than-lifetime exposure.

#### 5.2.6.2 Toxicity Values for Carcinogenic Effects

For carcinogens, the EPA has developed a classification system based on the weight of evidence that a compound is a human carcinogen. The classification system is defined as:

- Group A - Human Carcinogen
- Group B - Probable Human Carcinogen
  - B1 - limited human data are available
  - B2 - sufficient evidence in animals and inadequate or no evidence in humans
- Group C - Possible Human Carcinogen
- Group D - Not classifiable as to human carcinogenicity
- Group E - Evidence of non-carcinogenicity for humans

For COIs classified by EPA as potential human carcinogens, risk is evaluated differently, because noncarcinogenic and carcinogenic effects are believed to have different mechanisms of action. Typically animal carcinogenicity studies are conducted using relatively high doses. To evaluate the possibility of developing cancer at the low doses more frequently encountered in the environment, the linearized multistage model is used. This mathematical model expresses cancer risk as a function of exposure. The model is based on the assumption that even a single, low-dose exposure to a carcinogen may result in cancer. In other words, it is assumed that there is no threshold for any dose of a compound classified as a carcinogen.

The EPA's Carcinogen Assessment Group reviews human, animal and *in vitro* data regarding suspected chemical carcinogens and calculates cancer slope factors (CSFs) for those determined to be carcinogens. CSFs are upper-bound estimates of the excess cancer risk due to continuous exposure to a COI averaged throughout the course of a 70-year lifetime. A CSF has units of milligrams of chemical per kilogram of body weight per day [1/(mg chemical/kg body weight-day)] or 1/(mg/kg-day) and provides a

health-protective estimate of the probability of developing cancer from exposure over a lifetime. By definition, there is only a 5 percent chance that the probability of developing cancer is higher. The basis of a CSF is data from lifetime animal bioassays, although human data are used when available. The CSF represents the upper 95% confidence limit of the slope of the linear portion of the dose-response curve. The excess carcinogenic risk for the experimental animal is then extrapolated to the excess carcinogenic risk expected for humans. The resulting values from this model are more likely to overestimate than to underestimate the potential risk.

### 5.2.6.3 Toxicity Information for COI

Verified toxicity values were obtained from the current (May 1996) U.S. EPA Region III's Risk Based Concentration Table which utilizes the EPA's *Integrated Risk Information System* (IRIS) on-line computer database (EPA, 1995) as a primary source. These toxicity values and other chemical-specific information are included in IRIS after a comprehensive review of toxicity data by work groups of EPA health scientists. Verified toxicity values are the most reliable for estimating carcinogenic and noncarcinogenic risks due to COI exposure. Therefore, the toxicity values used for the COIs for this risk assessment are as follows:

Constituent	Inhalation / Oral	Cancer Slope Factor (CSF) (Kg-day/mg)	Reference Dose (RfD) (mg/Kg-day)
Vinyl Chloride	Inhalation	0.3	N/A
c-1,2-Dichloroethene	Inhalation	N/A	N/A
Trichloroethene	Inhalation	0.006	N/A
Vinyl Chloride	Oral	1.9	N/A
c-1,2-Dichloroethene	Oral	N/A	0.01

### 5.2.7 Uncertainties Associated with the Toxicity Assessment

Uncertainties associated with the toxicity assessment include:

- The quality of the studies used as the basis for the COI-specific toxicity values;





- Potential differences in toxicity and absorption efficiency between laboratory animals and humans;
- The applicability of studies conducted in experimental laboratory animals at high dose levels to human exposures at lower concentrations;
- The validity of the critical underlying assumption in the dose response model for carcinogens that there is no threshold for carcinogenesis (i.e., there is no dose of a carcinogen that is not associated with a risk of cancer);
- Calculation of lifetime excess cancer risk on the basis of less than a lifetime exposure;
- Potential synergistic or antagonistic interactions of chemicals to which the same individual may be exposed;
- Oral toxicity values used when no inhalation toxicity values were available; and
- Use of chronic toxicity values to evaluate short-term subchronic exposures when subchronic values are unavailable.

Because of these uncertainties, methods for developing toxicity values (RfDs and CSFs) are designed to be conservative. For example, cancer slope factors derived by the EPA are for the most part based on the upper 95th confidence limit. The use of uncertainty factors in the derivation of RfDs are devised to be health protective, accounting for limitations in available data and extrapolation from experimental conditions to exposure scenarios identified for site specific-conditions. As a result, calculation of risks using EPA-derived toxicity values should be conservatively protective of human health.

#### **5.2.8 Calculation of Tier III Human Health Carcinogenic and Non-carcinogenic Risks**

Once the exposure pathways, parameters, and toxicity values are identified, the Tier III human health risks can be calculated. There are two general equations used in calculating potential human health effects for carcinogens and non-carcinogens. Both of these equations are based on the estimated chronic daily intakes (CDI) calculated for each receptor and pathway retained for quantitative risk assessment. The equations for the CDIs are presented on the risk calculation summary tables (Tables 16 through 20). The formulae for the CDIs are taken directly from the EPA RAGS guidance document (EPA, 1989a). These same formulae are presented in terms of calculating remedial goals in the IDEM guidance document for Tier II Cleanup Goals (IDEM, 1996).



For carcinogenic effects, the excess cancer risk due to a lifetime exposure to the estimated chronic daily intake of each carcinogen is calculated using the following equation:

$$\text{CANCER RISK} = \text{CSF} \times \text{CDI}$$

where CSF is the cancer slope factor and CDI is the lifetime estimated chronic daily intake (CDI) or dose. Since the units of CSF are  $(\text{mg/kg-day})^{-1}$  and the units of dose or intake are  $(\text{mg/kg/day})$ , the risk is unitless.

For compounds classified as carcinogens, the estimated risks appear in scientific notation. Thus a risk of  $1 \times 10^{-6}$  means that one additional person in an exposed population of one million (1,000,000) individuals may develop cancer during a lifetime of exposure to the compound. IDEM has adopted a cumulative incremental cancer risk (ICR) limit of  $1 \times 10^{-6}$  as the point of departure for sites with unrestricted future use (i.e., includes residential) and  $1 \times 10^{-5}$  as the target cancer risk level for current and future land use restricted to non-residential purposes. In this assessment, the site was assumed to remain non-residential, therefore, a risk limit of  $1 \times 10^{-5}$  was used to evaluate Tier III carcinogenic risks on site. A risk limit of  $1 \times 10^{-6}$  was used to evaluate Tier III carcinogenic risks off site.

Noncarcinogenic effects were quantified using the hazard index approach as recommended by IDEM. A hazard index (HI) is the ratio of the estimated chronic daily intake and a reference dose considered to be the level where adverse health effects would not be observed (these doses have also been called "safe" or "acceptable").

$$\text{HI} = \text{CDI/RfD}$$

CDI is the estimated chronic daily intake and the RfD is the reference dose. Since the units of CDI and reference dose (RfD) are both  $(\text{mg/kg-day})$  the hazard index (HI) is unitless.

According to IDEM, a HI less than 1.0 suggests that no adverse health effects would result from exposure to compounds that do not bioaccumulate and 0.2 as a HI for compounds that bioaccumulate. Table 1 of the Water Quality Criteria for Specific Substances (Indiana Register, Volume 16, Number 7, April 1, 1993) was the basis for determining whether a compound bioaccumulates. None of the COIs evaluated in this assessment bioaccumulate.



These equations were then used to calculate direct contact health-based carcinogenic and non-carcinogenic risks for each COI for soil, groundwater, and surface water using IDEM's defined cancer risk limit and hazard indices for retained residential (off-site) and non-residential (on-site) scenarios. Note again that quantitative evaluations of off-site impacted groundwater residential use has not been performed since the Residential Tier II Cleanup Levels were specifically developed for protection of this scenario.

#### **5.2.8.1 Tier III Non-Residential Risks**

Tier III carcinogenic and non-carcinogenic human health risks for on-site workers' non-residential surface and subsurface soil exposures are summarized on Tables 16 and 17, respectively. Tier III carcinogenic and non-carcinogenic human health risks for on-site construction workers' non-residential surface and subsurface soil exposures are summarized on Table 18. Since subsurface soil data were used for actual subsurface soil conditions as well as worst case surface soil conditions and all exposure inputs for risk calculations are the same for both surface and subsurface exposures for an on-site construction worker, the resulting risks for either exposure are the same. Thus, they are both presented on one risk calculation summary table.

#### **5.2.8.2 Tier III Residential Risks**

As explained above, residential surface water exposures have been examined for an adolescent age category of 12 through 18 years old based on this being the most likely receptor for this type of exposure. Tier III non-carcinogenic human health risks for the off-site adolescent residential surface water exposures are summarized on Table 19. Tier III carcinogenic human health risks for the off-site residential indirect contact groundwater exposures are summarized on Table 20.

As stated above in Section 5.2.4, off-site residential groundwater exposures were assessed by comparing groundwater concentrations of each COI to its respective Tier II Residential Goal. Since residential groundwater exposures can only occur (even potentially) for groundwaters off of the Allison Plant No. 10 site, Tier II Residential goals need only be evaluated at the property boundary and/or monitoring well locations off-site. This exercise was performed in Section 5.5.2. All current groundwater results for positively detected VOC's were presented along with the Tier II Non-Residential and Tier II Residential Goals. Off-site groundwater locations discussed in Section 5.5.2 to the west or south of the facility were not evaluated as Little Eagle Creek was assumed to be the only realistic receptor of the plume in the western portion of the property moving towards the south-southeast. Of the five off-site groundwater sample locations to the southeast of the facility (MW-151, MW-156, MW-157, MW-201, and MW-301), the wells MW-201 and MW-301 monitor deeper aquifers that have shown no evidence of the same impact

found in the upper aquifer. Well MW-151 and MW-156 had positive detections of cis-1,2-dichloroethene in the current sampling but the concentrations were well below the Tier II Residential Cleanup Level of 70 ug/L. Wells MW-156 (52 ug/L) and MW-157 (100 ug/L) had trichloroethene results exceeding their respective Tier II Residential Goal of 5 ug/L. The concentration for trichloroethene in MW-157 was used as a worst-case representative concentration term for the off-site groundwater-to-indoor air exposure assessment.

On-site groundwater sample location MW 10-1, located a few feet west of the eastern property line along Olin Avenue, had trichloroethene (810 ug/L) and cis-1,2-dichloroethene (120 ug/L) concentrations above their respective Tier II Residential Goals of 5 ug/L and 70 ug/L, respectively.

### 5.3 Risk Assessment Conclusions

Site-specific human health risks were calculated for the Allison Plant No. 10 site located on Olin Avenue in Indianapolis, Indiana using IDEM and EPA risk assessment methodology. A summary of all carcinogenic risks calculated for all soil exposure pathways and all receptors described in Sections 5.2.8.1 and 5.2.8.2, are presented in Table 21. As can be seen from the summary of risks in Table 21, no soil carcinogenic risks for non-residential exposures to soils exceeded the  $1 \times 10^{-5}$  target risk level. The only on-site soil COI, vinyl chloride, does not have non-carcinogenic toxicity constants. Therefore, no soil non-carcinogenic hazard indices for non-residential exposures were estimated. On-site and off-site soil COI concentrations found do not appear to pose a significant human health threat.

The surface water non-carcinogenic risks, also presented in summary in Table 21, were below the EPA's target hazard index of 1.0. Cis-1,2-dichloroethene, the only surface water COI, does not have carcinogenic toxicity constants. Therefore, no surface water carcinogenic risk levels were estimated. Off-site surface water COI concentrations found do not appear to pose a significant human health threat.

Based on the noted exceedances of the Tier II Residential Goals at property boundaries and/or at off-site locations, it is apparent that potentially unacceptable risks are posed by potential direct contact (ie ingestion) groundwater exposures to off-site residents in the immediate vicinity of the subject site. However, an evaluation of volatilized vapor from groundwater to indoor air using data from well MW-157 posed no significant human health threat for offsite residents.

The methodology used throughout this report is in compliance with both State of Indiana and federal regulations and guidance for protection of the environment. The human health risk assessment performed is based on the assumption that the site will remain industrial, site surface conditions will remain fairly constant, and the future potable water source will remain as the public water supply. The purpose of

calculating human health risks is to provide information to General Motors that assists them in making informed decisions regarding whether remedial actions may be necessary for the site.

The individual risks were calculated using all available data provided to Fluor Daniel GTI, Inc. and by following IDEM (1994) and EPA guidance documents. In cases where the available data were limited, reasonable assumptions were used and are clearly documented. Additionally, uncertainties inherent in the process were summarized throughout this section. Generally, the uncertainties error on the side of conservatism. Therefore, overall the human health risks estimated are conservative and are not likely to underestimate potential risks to potentially exposed receptors.

## 6.0 SUMMARY & CONCLUSIONS

Fluor Daniel GTI, Inc. has completed a Remedial Investigation for the Allison Engine Company, Plant 10 in Indianapolis, Indiana. The scope of work has been completed, and when considered as a whole, to be consistent with the National Contingency Plan as referenced in 40 CFR 300.700 (Subpart H-Participation by Other Persons). The purpose of the investigation was to better define the magnitude and extent of volatile organic compounds (VOCs) in the soil and groundwater and to assess potential environmental risks to their occurrence. Metals in surface soil were also investigated.

Activities completed during the investigation included the advancement of fourteen soil borings, one Hydropunch, and six Geoprobe borings; collection of soil samples for laboratory analysis; the installation of nine shallow and five deep monitoring wells in the fourteen borings; surveying of all new wells; groundwater elevation monitoring and sampling of all wells on-site; stream survey and sampling of Little Eagle Creek; and rising head permeability tests from the newly installed wells. Results of the investigation were used to more fully characterize the geology and hydrogeology of the site, to further delineate VOCs and metals occurrence, and to assess the potential risk of VOCs and metals occurrence to human health and the environment.

- Surface elevations at the site range from approximately 715 feet to 705 feet near Little Eagle Creek to the south. The subsurface of the site area is characterized by two thick layers of sand separated by a layer of silty clay. Another discontinuous layer of silty clay is found at the surface. The lower sand unit was not encountered at the maximum depth of penetration (65 feet) in the western area. Based on a comparison to published data, the two sand units are assumed to be the middle and lower confined aquifers of Meyer et al (1975). The intermediary silty clay unit ranges in thickness from approximately 8 feet to >33 feet. According to Meyer, et al, (1975), this clay layer acts as a semipervious confining bed (aquitard).



- Based on data collected during three gauging events in 1995 and 1997, groundwater occurs at elevations ranging from 698.92 to 703.75 feet in the shallow water bearing unit, 698.83 to 701.00 feet in the lower sand unit, and 689.10 to 700.68 feet in the intermediary clay unit. Groundwater elevation data indicates groundwater flows generally towards the south (Little Eagle Creek). A comparison of groundwater elevations in the three well clusters indicated a downward gradient in the western portion of the site and east of the plant. An upward gradient was observed offsite to the southeast. Rising head permeability tests indicated average hydraulic conductivities of 137 feet per day in the shallow sand unit, 8.7 feet per day in the lower sand unit, and 0.012 feet per day in the intermediary clay. Based on the low hydraulic conductivity of the intermediary unit, it appears to act as an aquitard between the aquifers.
- Analytical results for soil samples collected from the vadose zone during the current and previous investigations indicated the presence of VOCs in 17 of the 23 samples collected. TCE and 1,2-DCE were the most frequently detected compounds. Concentrations of TCE ranged from 29 ug/kg to 120,000 ug/kg. 1,2-DCE concentrations ranged from 4 ug/kg to 12,000 ug/kg. Levels of adsorbed VC ranged from 12 ug/kg to 500 ug/kg. TCE was detected on site at one location above the Tier II Non-Residential Closure Goal of 25,730 ug/kg. VC was detected at one location above its Tier II Non-Residential Closure Goal of 130 ug/kg. Using the Tier II Non-Residential Closure Goals as delineation, VOCs occurrence in soil has been defined.
- Using TCE as an indicator, multiple source areas appear to be present in the western portion of the site (e.g.: MW-132, GP-2, and MW-133). A soil sample collected from the air/water interface southeast of the plant building (MW10-1) contained 3,800 ug/kg TCE. This value was within the same order of magnitude as two groundwater samples collected from this location, therefore, it is not clear whether a source is present in this area. Levels of TCE an order of magnitude lower were measured in samples collected from the vadose zone on the southeast side of the plant building (MW-152) and further to the south (GP-5). These may represent other small source areas.
- One sample collected southeast of the property contained a TCE concentration above the Tier II Residential Cleanup Goal. The sample, collected from a depth of 18-20 feet contained 170 ug/kg TCE which is above the Tier II Residential Cleanup Goal of 80 ug/kg. This sample was however, collected from below the water table. The groundwater sample collected from this location contained 280 ug/l TCE and therefore the soil results may reflect the presence of TCE in the groundwater.
- A total of 28 of the 41 groundwater samples collected from monitoring wells during the period of July 1995 to February 1997 contained detectable concentrations of VOCs. Samples from seven



of the wells were below detection limits for all analyzed constituents. As was the case with soil, the most frequently detected compounds were TCE and 1,2-DCE. Analytical data indicate detectable TCE concentrations ranged from 5.4 ug/L to 13,000 ug/L, {cis} 1,2-DCE concentrations ranged from 5.3 ug/L to 65,000 ug/L, {trans} 1,2-DCE concentrations ranged from 5.9 ug/L to 1,400 ug/L, and detectable VC concentrations ranged from 12 ug/L to 3,400 ug/L. Wells located west, southwest, and southeast of the building and/or property contained TCE, 1,2-DCE, and/or VC concentrations above the Tier II non-residential cleanup goals. Based on this data, VOCs occurrence in groundwater has not been delineated horizontally south and east of MW-157. However, two additional wells are planned for this area. VOCs occurrence in groundwater south of HP-1 near Little Eagle Creek also has not been delineated. Shallow groundwater likely discharges into Little Eagle Creek, and therefore, it is unlikely that dissolved VOCs occurrence extends south of the creek.

- Based on isoconcentration maps constructed for TCE, 1,2-DCE, and VC in groundwater, at least two potential source areas of elevated concentrations were identified. These areas are west of the building in the vicinity of MW-132 and southeast of the building in the vicinity of MW10-1. Non-determined aliphatic hydrocarbons were detected in samples collected from MW-157 offsite to the southeast. The occurrence of these compounds appears to be localized in the vicinity of the well and not the site.
- Groundwater data collected during previous investigations were compared to recent data to evaluate trends in dissolved VOCs concentrations. Historical dissolved VOCs data are provided in Table 7. In general, most of the wells did not exhibit major changes in dissolved VOCs concentrations with time. Dissolved VOCs concentrations did increase in wells MW-132 and MW155. Detected concentrations decreased in wells MW-148, MW-153, and MW-156. Wells MW-132 and MW155 are located in the western potential source area. Well MW-148 is located downgradient of MW-132. MW-153 is located in the well cluster located southwest of the building and MW-156 is located offsite to the southeast.
- The discharge (stream flow volume) of Little Eagle Creek was measured on October 4, 1996 and February 10, 1997. Maximum stream flows of 8 cfs and 23.77 cfs were measured for these dates, respectively. Data collected from a gauging station 1.2 miles upstream indicated historical average flows of 11.1 cfs and 30.54 cfs, respectively, for the two months. This suggests that the gauging station data could be used to describe general stream flow trends.

Loading of VOCs to Little Eagle Creek were estimated using concentrations in groundwater at HP-1 and the above stream flow data. A concentration of 25 ug/L 1,2-DCE was predicted to be detected in Little Eagle Creek using the October, 1996 flow data. The actual concentration



measured in Little Eagle Creek near HP-1 in October, 1996 was 17 ug/L. The predictive model and laboratory analytical results both indicated that detectable TCE and VC concentrations were not present in Little Eagle Creek in October 1996 and February 1997. Both also indicated that detected 1,2-DCE concentrations were not present in February 1997.

- Site-specific human health risks were calculated for the site using IDEM and EPA risk assessment methodology. No soil carcinogenic risks for non-residential exposures to soils exceeded the  $1 \times 10^{-5}$  target risk level. Assessed non-residential scenarios included the on-site worker and on-site construction worker exposure to surface and subsurface soil. The only on-site soil COI, vinyl chloride, does not have non-carcinogenic toxicity constants. Therefore, no soil non-carcinogenic hazard indices for non-residential exposures were estimated. On-site soil COI concentrations found do not appear to pose a significant human health threat. No off-site soil COI were identified that required assessment.
- Based on the noted exceedances of the Tier II Residential Goals at property boundaries and/or at off-site locations, it is apparent that potentially unacceptable risks are posed by potential direct contact (ie ingestion) groundwater exposures to off-site residents in the immediate vicinity south and east of the subject site. However, an evaluation of volatilized vapor from groundwater to indoor air using data from well MW-157 posed no significant human health threat for offsite residents. The only known water well in the site area was sampled by the MCHD on January 2, 1997 and the sample did not contain any detectable VOC concentrations. No on-site groundwater COI were identified that required assessment.
- The surface water non-carcinogenic risks were below the EPA's target hazard index of 1.0. Cis-1,2-dichloroethene, the only surface water COI, does not have carcinogenic toxicity constants. Therefore, no surface water carcinogenic risk levels were estimated. Off-site surface water COI concentrations found do not appear to pose a significant human health threat.





## 7.0 RECOMMENDATIONS

- TCE occurrence in groundwater has not been delineated southeast of the site. Additional wells should be and are planned to be installed south and east of MW-157.
- Based on the findings of the Remedial Investigation some potential unacceptable risks are posed by groundwater exposures to off-site residents in the immediate vicinity south and east of the subject site. Site specific cleanup goals need to be determined for VOCs occurrence in groundwater to mitigate the potential offsite risks. The cleanup goals will be used to determine the need for remediation (if warranted) and the type of technologies to be employed.
- Asbestos occurrence in the northwestern portion of the site has not been fully investigated. Additional investigation activities are planned in this area to identify the magnitude and extent of asbestos occurrence.



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**TABLE 1**  
**SUMMARY OF DETECTED VOCs CONCENTRATIONS IN SOIL**  
**HISTORICAL DATA**  
**GENERAL MOTORS - ALLISON PLANT 10**

BORING ID	SAMPLE DATE	SAMPLE DEPTH (feet)	SAMPLE ANALYTICAL RESULT						
			VINYL CHLORIDE	TETRA-CHLORO-ETHENE	TOTAL-1,2-DICHLORO-ETHENE	TRICHLORO-ETHENE	METHYLENE CHLORIDE	TOLUENE	TOTAL XYLENES
SB-132 <sup>1</sup>	9/92	8-10	<6300	<3100	12000	<b>120000</b>	<3100	<3100	<3100
SB-133 <sup>1</sup>	9/92	3-5	<1300	<630	<630	14000	<630	<630	<630
SB-134 <sup>1</sup>	9/92	8-10	<10	<5	<5	<5	<5	<5	<5
SB-135 <sup>1</sup>	9/92	8-10	<10	<5	<5	<5	<5	<5	<5
		DUPL	<10	<5	<5	<5	<5	<5	<5
SB-145 <sup>1</sup>	5/93	13-15	<500	<100	1200	<100	<1000	<100	<100
		DUPL	<500	<100	<600	<100	<1000	<100	<100
		28-30	<10	<5	<5	<5	18	<5	<5
SB-146 <sup>1</sup>	5/93	13-15	<10	<5	<5	93	12	<5	<5
		23-25	<10	13	<5	<5	15	8	<5
SB-147 <sup>1</sup>	5/93	8-10	<500	<100	1000	<b>23000</b>	<1000	<100	<100
		28-30	<10	<5	<5	<5	<21	<24	<5
SB-148 <sup>1</sup>	5/93	8-10	<500	<100	900	14000	<1000	<100	<100
		23-25	<10	<5	15	14	<10	12	<5
SB-149 <sup>1</sup>	5/93	8-10	<500	<100	1400	200	<1000	<100	<100
SB-150 <sup>1</sup>	5/93	3-5	660	700	<100	4200	<1000	<100	<400
		8-10	<500	<100	1800	300	<100	<100	<100
SB10-1 <sup>2</sup>	3/94	2-4	<1	<1	4	45	NA	<1	<3
SB10-2 <sup>2</sup>	3/94	6-8	<5	<5	490	29	NA	<5	<16
SB10-3 <sup>2</sup>	3/94	4-6	<1	<1	71	<1	NA	<1	<3
SB10-4 <sup>2</sup>	3/94	6-8	<120	<120	<120	<120	NA	<120	1300
SB10-5 <sup>2</sup>	3/94	14-16	<120	<120	<120	2500	NA	<120	<360
MW10-1 <sup>2</sup>	3/94	10-12	<110	<110	<110	3800	NA	<110	<330
TIER II NON- RESIDENTIAL GOALS			130	8,010	102,490	25,730	not determined	1,000,000	1,000,000
TIER II RESIDENTIAL GOALS			130	230	17,140	80	not determined	202,160	1,000,000

NOTES: Analytical results are in ug/kg: parts per billion (ppb).

1) Samples collected by ESI.

2) Samples collected by OBG.

Bolded values are greater than Tier II non-residential goals.



**TABLE 1B**  
**SUMMARY OF METAL CONCENTRATIONS IN SOIL**  
**HISTORICAL DATA**  
**GENERAL MOTORS - ALLISON PLANT 10**

BORING ID	SAMPLE DEPTH (feet)	PRIORITY POLLUTANT METALS (mg/kg)							
		Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
SB10-1	2-4	8.4	290	8	39	1000	0.1	1.6	<1
SB10-2	6-8	4.6	19	<1	6	9.4	<1	2.1	<1
SB10-3	4-6	3.6	26	<1	9	5.4	0.1	2.3	<1
SB10-4	6-8	7.2	83	<1	22	13	<0.1	<0.6	<1
SB10-5	14-16	2.1	<11	<1	4	3.9	<0.1	3.3	<1
MW10-1	10-12	3.4	<11	<1	6	4.8	0.1	2.1	<1
TIER II NON-RESIDENTIAL GOALS		438	10000	730	10000/7300	NA	87.60	7300	7300
TIER II RESIDENTIAL GOALS		438	10000	730	10000/7300	NA	87.60	7300	7300

NOTES: Analytical results are in mg/kg; parts per million (ppm).  
Samples collected by Fluor Daniel GTI, Inc.



**TABLE 2**  
**SUMMARY OF WELL AND CREEK GAUGING DATA**  
**GENERAL MOTORS - ALLISON PLANT 10**

WELL ID	TOC ELEV. (FEET)	SCREEN INTERVAL (FEET)	DATE GAUGED	DTW (FEET)	GROUNDWATER ELEV. (FEET)
MW-10-1	714.04	7-17	7/14/95	14.07	699.97
			9/11/95	14.25	699.79
			2/5/97	12.75	701.29
MW-132	712.17	10-20	7/14/95	11.39	700.78
			9/11/95	11.49	700.68
			2/5/97	10.25	701.92
			2/26/97	11.17	701.00
MW-133	708.79	8-18	9/11/95	8.84	699.95
			2/5/97	7.29	701.50
MW-135	713.69	10-20	7/14/95	13.28	700.43
			9/11/95	13.66	700.03
			2/5/97	11.96	701.73
			2/26/97	12.47	701.22
MW-145	707.90	18-28	7/14/95	8.65	699.05
			9/11/95	8.85	699.05
			2/5/97	7.43	700.47
MW-146	708.67	15-25	7/14/95	9.41	699.26
			9/11/95	9.44	699.23
			2/5/97	7.95	700.72
MW-147	711.88	20-30	7/14/95	11.09	700.79
			9/11/95	11.20	700.68
			2/5/97	9.91	701.97
MW-148	711.00	10.5-25.5	7/14/95	10.43	700.57
			9/11/95	10.50	700.50
			2/5/97	8.25	702.75
			2/26/97	10.15	700.85
MW-150	712.93	4-19	9/11/95	13.30	699.63
			2/5/97	11.75	701.18
MW-151	712.96	5-20	7/14/95	13.93	699.03
			9/11/95	14.04	698.92
			2/5/97	12.80	700.16
MW-152	713.06	5-20	7/14/95	13.45	699.61
			9/11/95	13.57	699.49
			2/5/97	12.21	700.85
			2/26/97	12.92	700.14



**TABLE 2**  
**SUMMARY OF WELL AND CREEK GAUGING DATA**  
**GENERAL MOTORS - ALLISON PLANT 10**

WELL ID	TOC ELEV. (FEET)	SCREEN INTERVAL (FEET)	DATE GAUGED	DTW (FEET)	GROUNDWATER ELEV. (FEET)
MW-153	711.64	4.5-19.5	7/14/95	11.77	699.87
			9/11/95	11.76	699.88
			2/5/97	9.78	701.86
			2/26/97	11.14	700.50
MW-154	714.22	5-20	7/14/95	13.31	700.91
			9/11/95	13.42	700.80
			2/5/97	12.17	702.05
			2/26/97	13.07	701.15
MW-155	717.52	14-29	9/11/95	16.78	700.74
			2/5/97	15.71	701.81
			2/26/97	16.70	700.82
MW-156	711.69	5-20	9/11/95	12.21	699.48
			2/5/97	10.65	701.04
MW-157	711.30	5-20	2/5/97	10.71	700.59
			2/26/97	11.14	700.16
MW-158	720.05	14-29	2/5/97	17.95	702.10
			2/26/97	19.14	700.91
MW-200	713.03	45-50	7/14/95	14.20	698.83
			2/5/97	11.96	701.07
MW-201	712.29	36-38	7/14/95	13.15	699.14
			9/11/95	12.99	699.30
			2/5/97	11.65	700.64
			2/26/97	12.12	700.17
MW-202	711.88	33-35	7/14/95	22.78	689.10
			9/11/95	12.33	699.55
			2/5/97	11.20	700.68
			2/26/97	12.29	699.59
MW-301	712.75	45-50	2/5/97	11.75	701.00
MW-302	711.54	45-55	2/5/97	11.26	700.28
			2/26/97	12.33	699.21
Holt Gauge	702.57	N/A	2/26/97		
Olin Gauge	698.75	N/A	2/26/97		

NOTES: TOC ELEV. - Elevation at the top of the PVC well casing relative to the on-site datum.  
DTW. - Depth to groundwater in feet.  
GROUNDWATER ELEV. - Elevation of groundwater in the well using the depth to water.



**TABLE 5**  
**SUMMARY OF SOIL VAPOR HEADSPACE READINGS**  
**GENERAL MOTORS - ALLISON PLANT 10**

SAMPLE DEPTH (FEET)	PID READING (PPMV)																	
	MW- 152	MW- 154	MW- 155	MW- 156	MW- 157	MW- 158	MW- 200	MW- 201	MW- 202	MW- 301	MW- 302	GP-1	GP-2	GP-3	GP-4	GP-5	SP-1	HP-1
0-2	--	--	--	--	--	--	--	--	--	--	--	4.6	4.6	15	1.3	2.8	--	--
3-5	0.0	3.8	0.0	0.4	1.8*	250	0.0	0.0	0.0	--	--	--	--	--	--	--	0.0	0.0*
5-7	--	--	--	--	--	--	--	--	--	--	--	5.2	24	44	2.0	2.0	--	--
8-10	0.0*	3.9*	0.0	0.5	--	>1000*	--	0.0	0.0	--	--	--	--	--	--	--	2.2	--
9-11	--	--	--	--	1.6	--	--	--	--	--	--	--	--	--	--	--	--	--
10-12	--	--	--	--	--	--	--	--	--	--	--	52	17	2.5	3.0	6.4	--	--
13-15	0.0	2.2	200*	0.4	6.0	150	2.0*	0.0	14.8*	--	--	--	--	--	--	--	9.2	--
18-20	7.5*	3.2*	85	1.0*	6.9	102	0.0	8.4*	8.2	--	--	--	--	--	--	--	8.0	--
23-25	--	--	1.0	--	--	4.0	1.0	0.0	0.2	--	--	--	--	--	--	--	0.0	--
28-30	--	--	7.0*	--	--	3.5	0.0	5.8	0.0	--	--	--	--	--	--	--	--	--
33-35	--	--	--	--	--	--	1.4	0.0	0.0*	--	--	--	--	--	--	--	--	--
38-40	--	--	--	--	--	--	0.2	0.0*	--	--	28	--	--	--	--	--	--	--
43-45	--	--	--	--	--	--	0.7	--	--	9.0	160	--	--	--	--	--	--	--
45-47	--	--	--	--	--	--	--	--	--	6.4	--	--	--	--	--	--	--	--
47-49	--	--	--	--	--	--	--	--	--	12	--	--	--	--	--	--	--	--
48-50	--	--	--	--	--	--	0.0*	--	--	--	540*	--	--	--	--	--	--	--
49-51	--	--	--	--	--	--	--	--	--	9.2	--	--	--	--	--	--	--	--
53-55	--	--	--	--	--	--	--	--	--	--	180	--	--	--	--	--	--	--
58-60	--	--	--	--	--	--	--	--	--	--	300	--	--	--	--	--	--	--
63-65	--	--	--	--	--	--	--	--	--	--	200*	--	--	--	--	--	--	--

NOTES: PPMV - Parts per million by volume  
 -- - No sample at this depth.  
 \* - Sample collected for laboratory analysis.



**TABLE 6**  
**SUMMARY OF VOCs CONCENTRATIONS IN SOIL FOR WELLS AND BORINGS**  
**INSTALLED BY FLUOR DANIEL GTI**  
**EPA METHOD 8240**  
**GENERAL MOTORS - ALLISON PLANT 10**

BORING ID	SAMPLE DEPTH (feet)	DATE SAMPLED					
			VINYL CHLORIDE	cis-1,2-DICHLORO-ETHENE	trans-1,2-DICHLORO-ETHENE	TRICHLORO-ETHENE	TETRACHLORO-ETHENE
MW-152	8-10	6/27/95	<10	<5	<5	300	<5
	18-20	6/28/95	<10	<5	<5	<5	<5
MW-154	8-10	6/29/95	<10	<5	<5	<5	<5
	18-20		<10	<5	<5	<5	<5
MW-155	13-15	9/5/95	60	3500	<5	390	<5
	28-30		<10	<5	<5	<5	<5
MW-156*	18-20	9/5/95	<10	<5	<5	170	14
MW-157	3-5	1/23/97	<10	<5	<5	<5	<5
MW-158	8-10	1/23/97	<10	<5	<5	<5	<5
MW-200	13-15	7/10/95	<10	33	<5	280	18
	48-50	7/14/95	<10	<5	<5	<5	<5
MW-201*	18-20	7/11/95	<10	90	11	<5	<5
	38-40	7/11/95	<10	<5	<5	<5	<5
MW-202	13-15	7/11/95	24	1100	<5	8300	<5
	33-35	7/11/95	<10	<5	<5	6.8	<5
MW-302	48-50	1/31/97	<10	<5	<5	<5	<5
	63-65		<10	<5	<5	<5	<5
GP-1	5-7	12/19/96	40	2700	25	12000	<5
GP-2	5-7	12/19/96	<10	130	<5	<5	<5
GP-3	5-7	12/19/96	12	<5	<5	<5	<5
GP-4	5-7	12/19/96	<10	<5	<5	77	<5
GP-5	5-7	12/19/96	<10	<5	<5	180	<5
GP-6	5-7	12/19/96	<10	<5	<5	41	<5
HP-1*	3-5	9/6/95	<10	40	<5	<5	17
TIER II NON-RESIDENTIAL GOALS			130	102,490	not determined	25,730	8,010
TIER II RESIDENTIAL GOALS			130	17,140	not determined	80	230

NOTES: Analytical results are in ug/kg; parts per billion (ppb).  
Samples collected by Fluor Daniel GTI, Inc.  
MW wells were analyzed using EPA Method 8240.  
\* - Located off-site to the south or southeast. Considered potential residential exposure.  
Bolded value (MW156) indicates well of concern.



**TABLE 6B**  
**SUMMARY OF DETECTED PRIORITY POLLUTANT METAL CONCENTRATIONS IN SOIL**  
**FOR GEOPROBE BORINGS INSTALLED BY FLUOR DANIEL GTI**  
**DECEMBER 19, 1996**  
**EPA METHOD 6010**  
**GENERAL MOTORS - ALLISON PLANT 10**

BORING ID	SAMPLE DEPTH (feet)	PRIORITY POLLUTANT METALS (mg/kg)						
		Beryllium	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
GP-1	0-2	<0.5	<2	5.5	9.0	21	7.7	39
GP-2	0-2	<0.5	4.1	1600	510	940	28	880
GP-3	0-2	0.61	<2	16	21	9.0	21	60
GP-4	0-2	<0.5	<2	10	12	10	12	42
GP-5	0-2	<0.5	<2	9.7	7.4	13	8.5	36
GP-6	0-2	<0.5	<2	17	14	8.6	17	37
TIER II NON-RESIDENTIAL GOALS		13.49	1020	10000	not determined	NA	10000	10000
TIER II RESIDENTIAL GOALS		0.5	135	1350 or 10000	not determined	NA	5400	10000

NOTES: Analytical results are in mg/kg; parts per million (ppm)  
 Samples collected by Fluor Daniel GTI, Inc.



**TABLE 7**  
**SUMMARY OF VOCs CONCENTRATIONS IN GROUNDWATER**  
**FOR MONITORING WELLS -HISTORICAL DATA**  
**EPA METHOD 8240**  
**GENERAL MOTORS - ALLISON PLANT 10**

SAMPLE ID	SAMPLE DATE	SAMPLE ANALYTICAL RESULT				
		VINYL CHLORIDE	1,1-DICHLOROETHANE	trans-1,2-DICHLOROETHENE	cis-1,2-DICHLOROETHENE	TRICHLOROETHENE
MW-10-1	3/28/94	<100	<100	160		880
	10/5/94	-	-			1600
	7/14/95	<10	<5	5.9	190	1800
	2/5/97	<10	<5	<5	120	810
MW-132	9/92	1200	<50	1500		280
	5/93	<100	<20	2400		1900
	7/14/95	600	<5	15	5100	1700
	2/5/97	<250	<120	<120	65000	15000
MW-133	9/92	<10	<5	81		47
	5/93	5.3	<1	56		24
	9/11/95	<10	<5	<5	70	23
	2/5/97	<10	<5	<5	100	53
MW-135	9/92	<10	<5	<5		<5
	5/93	<5	<1	<1		<1
	7/14/95	<10	<5	<5	<5	<5
	2/5/97	<10	<5	<5	<5	<5
MW-145	5/93	<20	<5	440		9
	7/14/95	12	<5	<5	530	5.6
	2/5/97	<10	<5	<5	<5	43
MW-146	5/93	<5	<1	<1		83
	7/14/95	<10	<5	<5	<5	52
	2/5/97	<10	<5	<5	<5	43
MW-147	5/93	42	<1	<140		39
	7/14/95	<10	<5	<5	<5	<5
	2/5/97	<10	<5	<5	95	51
MW-148	5/93	490	<80	19000		4900
	7/14/95	92	23	1400	12	410
	2/5/97	<10	<5	<5	73	<5
MW-150	7/17/95	<10	<5	<5	6.7	65
	2/5/97	<10	<5	<5	<5	86
MW-151*	7/14/95	<10	<5	7.4	74	<5
	2/6/97	<10	<5	<5	20	<5
MW-152	7/14/95	<10	<5	<5	5.3	150
	2/5/97	<10	<5	<5	<5	150



**TABLE 7**  
**SUMMARY OF VOCs CONCENTRATIONS IN GROUNDWATER**  
**FOR MONITORING WELLS - HISTORICAL DATA**  
**EPA METHOD 8240**  
**GENERAL MOTORS - ALLISON PLANT 10**

SAMPLE ID	SAMPLE DATE	SAMPLE ANALYTICAL RESULT				
		VINYL CHLORIDE	1,1-DICHLOROETHANE	trans-1,2-DICHLOROETHENE	cis-1,2-DICHLOROETHENE	TRICHLOROETHENE
MW-153	7/14/95	22	<5	<5	980	570
	2/6/97	<10	<5	<5	<5	5.4
MW-153 DUPL	2/6/97	<10	<5	<5	<5	<5
MW-154	7/14/95	<10	<5	<5	<5	<5
	2/5/97	<10	<5	<5	<5	<5
MW-155	9/11/95	240	<5	<5	180	<5
	2/6/97	3400	<500	<500	17000	<500
MW-156*	9/11/95	<10	<5	<5	30	280
	2/6/97	<10	<5	<5	7.5	52
MW-156* DUPL	2/6/97	<10	<5	<5	6.9	50
MW-157	2/6/97	<100	<50	<50	<50	60
	2/26/97	<10	<5	<5	<5	100
MW-158	2/6/97	<10	<5	<5	<5	<5
MW-200	7/17/95	<10	<5	<5	<5	<5
	2/5/97	<10	<5	<5	<5	<5
MW-201*	7/14/95	<10	<5	<5	<5	<5
	2/6/97	<10	<5	<5	<5	<5
MW-202	7/14/95	<10	<5	<5	<5	<5
	2/6/97	<10	<5	<5	<5	<5
MW-301	2/6/97	<10	<5	<5	<5	<5
MW-302	2/6/97	<10	<5	<5	8.2	<5
HP-1*	9/3/95	500	<5	12	3900	430
TRIP BLANK	7/14/95	<10	<5	<5	<5	<5
	2/6/97	<10	<5	<5	<5	<5
EQUIPMENT BLANK	7/14/95	<10	<5	<5	<5	<5
	2/6/97	<10	<5	<5	<5	<5
TIER II NON-RESIDENTIAL GOALS		10	10,200	not determined	1,022	260
TIER I RESIDENTIAL GOALS		2	640	not determined	70	5

NOTES: Unit of data is ug/L.

9/92 & 5/93 Data collected by Engineering Science, Inc.

3/94 & 10/94 Data collected by O'Brien & Gere Engineers, Inc.

7/95, 9/95, & 2/97 Data collected by Fluor Daniel GTI, Inc.

Bolded values are greater than respective Tier II goals.

\* - Located off-site to the south or southeast. Considered potential residential exposure.



**TABLE 7B**  
**SUMMARY OF VOCs CONCENTRATIONS IN SURFACE WATER**  
**FROM LITTLE EAGLE CREEK**  
**EPA METHOD 8240**  
**GENERAL MOTORS - ALLISON PLANT 10**

SAMPLE ID	SAMPLE DATE	SAMPLE ANALYTICAL RESULT			
		VINYL CHLORIDE	cis-1,2-DICHLORO-ETHENE	TRICHLORO-ETHENE	METHYLENE CHLORIDE
ST-1	10/4/96	<10	<5	<5	<5
	2/10/97	<10	<5	<5	<5
ST-2	10/4/96	<10	17	<5	<5
	2/10/97	<10	<5	<5	<5
ST-2 DUPL	2/10/97	<10	<5	<5	<5
ST-3	10/4/96	<10	14	<5	<5
	2/10/97	<10	<5	<5	<5
Equipment Blank	2/10/97	<10	<5	<5	8.3
Trip Blank	10/4/96	<10	<5	<5	5*
TIER II NON-RESIDENTIAL GOALS		10	1,022	260	
TIER II RESIDENTIAL GOALS		2	70	5	

NOTES: Unit of data is ug/L.  
 Data collected by Fluor Daniel GTI, Inc.  
 Tier II goals listed are for groundwater.  
 \* Methylene Chloride was detected in the method blank at 5.9 ug/L.



Table 8		
General Motors - Allison Gas Plant 10		
Little Eagle Creek Flow Summary		
Summary of Little Eagle Creek Discharge Data		
Location	Flow (cfs)	
	October 1996	February 1997
<i>Upstream</i>	4 *	20.88
<i>Midpoint</i>	8	23.77
<i>Downstream</i>	4 *	23.58
* indicates stream flow was too low to measure and was estimated		
Little Eagle Creek at Speedway Gaging Station		
	Flow (cfs)	
	October	February
<i>Max</i>	88.9	75.5
<i>Min</i>	0.81	3.82
<i>Mean</i>	11.1	30.4
Notes:		
(1) Gaging period: 1965 - 1995		
(2) Gaging station located approx. 1.2 miles upstream from site		

**TABLE 9**  
**SUMMARY OF SOIL LITERATURE BACKGROUND RANGES**  
**FOR TIER I METALS EVALUATIONS**  
**GENERAL MOTORS - ALLISON PLANT 10**

Analyte	Range of Background Results	Mean	Number of Samples In Background Range
Arsenic	3.6 - 15	7.5	11
Barium	300 - 700	500	11
Beryllium	ND - 2	0.36	11
Cadmium	N/A	1.15	60
Chromium	15 - 70	47	11
Copper	15 - 70	27	11
Lead	ND - 30	18	11
Mercury	0.04 - 0.26	0.109	11
Nickel	7 - 30	18	11
Selenium	ND - 0.5	0.35	11
Silver	ND - 5 *	—	1319
Zinc	32 - 113	56	11

**Notes:**

- All background concentrations are in units of mg/Kg.
- All literature values were taken from *Elements in North American Soils* (Dragun, 1991)
- Cadmium data were obtained from a source that did not provide a concentration range.
- "\*" Signifies a State of Indiana value was not available. Therefore, the background value for the conterminous USA was reported.
- ND indicates the lower range of the background was nondetected concentrations.



**TABLE 10**  
**SOIL FREQUENCY AND STATISTICAL SUMMARY**  
**ON-SITE VADOSE ZONE SUBSURFACE SOIL DATA**  
**GENERAL MOTORS-ALLISON PLANT 10**

ID	SB-132 (E)	SB-133 (E)	SB-134 (E)	SB-135 (E)	SB-147 (E)	SB-148 (E)	
DEPTH	8-10	3-5	8-10	8-10	8-10	8-10	
DATE	9/92	9/92	9/92	9/92	5/93	5/93	
<hr/>							
	<u>UNIT</u>						
Vinyl Chloride	ug/Kg	3150 U	650 U	5 U	5 U	250 U	250 U
Tetrachloroethene	ug/Kg	1550 U	315 U	2.5 U	2.5 U	50 U	50 U
Total-1,2-Dichloroethene	ug/Kg	12000	315 U	2.5 U	2.5 U	1000	900
Trichloroethene	ug/Kg	120000	14000	2.5 U	2.5 U	23000	14000
Toluene	ug/Kg	1550 U	315 U	2.5 U	2.5 U	50 U	50 U
Total Xylenes	ug/Kg	1550 U	315 U	2.5 U	2.5 U	50 U	50 U

ID	SB-149 (E)	SB-150 (E)	SB-150 (E)	SB10-1 (O)	SB10-2 (O)	SB10-3 (O)	
DEPTH	8-10	3-5	8-10	2-4	6-8	4-6	
DATE	5/93	5/93	5/93	3/94	3/94	3/94	
<hr/>							
	<u>UNIT</u>						
Vinyl Chloride	ug/Kg	250 U	500	250 U	0.5 U	2.5 U	0.5 U
Tetrachloroethene	ug/Kg	50 U	700	50 U	0.5 U	2.5 U	0.5 U
Total-1,2-Dichloroethene	ug/Kg	1400	50 U	1800	4	490	71
Trichloroethene	ug/Kg	200	4200	300	45	29	0.5 U
Toluene	ug/Kg	50 U	50 U	50 U	0.5 U	2.5 U	0.5 U
Total Xylenes	ug/Kg	50 U	200 U	50 U	1.5 U	8 U	1.5 U



**TABLE 10**  
**SOIL FREQUENCY AND STATISTICAL SUMMARY**  
**ON-SITE VADOSE ZONE SUBSURFACE SOIL DATA**  
**GENERAL MOTORS-ALLISON PLANT 10**

ID	SB10-4 (O)	MW-152	MW-154	GP-1	GP-2	GP-3	
DEPTH	6-8	8-10	8-10	5-7	5-7	5-7	
DATE	3/94	6/27/95	6/29/95	12/19/96	12/19/96	12/19/96	
<hr/>							
	<u>UNIT</u>						
Vinyl Chloride	ug/Kg	60 U	5 U	5 U	40	5 U	12
Tetrachloroethene	ug/Kg	60 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Total-1,2-Dichloroethene	ug/Kg	60 U	2.5 U	2.5 U	2725	130	2.5 U
Trichloroethene	ug/Kg	60 U	300	2.5 U	12000	2.5 U	2.5 U
Toluene	ug/Kg	60 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Total Xylenes	ug/Kg	1300	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U

ID	GP-4	GP-5	GP-6
DEPTH	5-7	5-7	5-7
DATE	12/19/96	12/19/96	12/19/96
<hr/>			
	<u>UNIT</u>		
Vinyl Chloride	ug/Kg	5 U	5 U
Tetrachloroethene	ug/Kg	2.5 U	2.5 U
Total-1,2-Dichloroethene	ug/Kg	2.5 U	2.5 U
Trichloroethene	ug/Kg	77	180
	ug/Kg	2.5 U	41
Toluene	ug/Kg	2.5 U	2.5 U
Total Xylenes	ug/Kg	2.5 U	2.5 U

**TABLE 10**  
**SOIL FREQUENCY AND STATISTICAL SUMMARY**  
**ON-SITE VADOSE ZONE SUBSURFACE SOIL DATA**  
**GENERAL MOTORS-ALLISON PLANT 10**

ID DEPTH DATE	UNIT	MINIMUM DETECTED	MAXIMUM DETECTED	LOCATION OF MAXIMUM DETECTED	FREQUENCY OF DETECTION	ARITHMETIC MEAN *	STANDARD DEVIATION *	NORMAL UPPER 95% CONFIDENCE INTERVAL *
Vinyl Chloride	ug/Kg	12	500	SB-150 (E)	3/21	115.3	186.7	187.5
Tetrachloroethene	ug/Kg	700	700	SB-150 (E)	1/21	135.9	361.8	272.1
Total-1,2-Dichloroethene	ug/Kg	4	12000	SB-132 (E)	10/21	998.3	2625.6	1986.7
Trichloroethene	ug/Kg	29	120000	SB-132 (E)	14/21	8973.6	26260.1	18858.6
Toluene	ug/Kg	ND	ND		0/21	104.9	338.1	NA
Total Xylenes	ug/Kg	1300	1300	SB10-4 (O)	1/21	171.5	425.7	331.7

*Note: (\*) The statistics calculated for vinyl chloride are based on the entire data set excluding the significant elevated detection limit reported for soil sample SB-132 as even the half-detection limit value of 3100 ug/kg is more than six times greater than the maximum detected concentration of 500 ug/kg in soil sample SB-150 and is not representative of the remaining data set. The exclusion of this data point has been done in accordance with EPA guidance from Section 5.3.2 of RAGS, Part A, Interim Final (1989a).*

ID DEPTH DATE	UNIT
Vinyl Chloride	ug/Kg
Tetrachloroethene	ug/Kg
Total-1,2-Dichloroethene	ug/Kg
Trichloroethene	ug/Kg
Toluene	ug/Kg
Total Xylenes	ug/Kg

**TABLE 11**  
**SOIL FREQUENCY AND STATISTICAL SUMMARY**  
**OFF-SITE VADOSE ZONE SUBSURFACE SOIL DATA**  
**GENERAL MOTORS-ALLISON PLANT 10**

ID	MW-157	MW-158	HP-1
DEPTH	3-5	8-10	3-5
DATE	1/23/97	1/23/97	9/6/95
<hr/>			
	UNITS		
Vinyl Chloride	ug/Kg 5 U	5 U	5 U
Tetrachloroethene	2.5 U	2.5 U	17
Total-1,2-Dichloroethene	2.5 U	2.5 U	40
Trichloroethene	2.5 U	2.5 U	2.5 U
Toluene	2.5 U	2.5 U	2.5 U
Total Xylenes	2.5 U	2.5 U	2.5 U

		MINIMUM DETECTED	MAXIMUM DETECTED	LOCATION OF MAXIMUM DETECTED	FREQUENCY OF DETECTION	ARITHMETIC MEAN	STANDARD DEVIATION	NORMAL UPPER 95% CONFIDENCE INTERVAL
<hr/>								
	UNITS							
Vinyl Chloride	ug/Kg	ND	ND	--	0/3	NA	NA	NA
Tetrachloroethene	ug/Kg	17	17	HP-1	1/3	7	8	13
Total-1,2-Dichloroethene	ug/Kg	40	40	HP-1	1/3	15	22	30
Trichloroethene	ug/Kg	ND	ND	--	0/3	NA	NA	NA
Toluene	ug/Kg	ND	ND	--	0/3	NA	NA	NA
Total Xylenes	ug/Kg	ND	ND	--	0/3	NA	NA	NA



**TABLE 12**  
**SURFACE AND SUBSURFACE SOIL LEAD & ASBESTOS**  
**STATISTICAL EVALUATIONS**  
**GENERAL MOTORS - ALLISON PLANT 10**

*Surface Lead Results (mg/kg)*

<u>Location</u>	<u>Depth</u>	<u>Concentration</u>
GP-1	0-2'	21
GP-2	0-2'	940
GP-3	0-2'	9
GP-4	0-2'	10
GP-5	0-2'	13
GP-6	0-2'	8.6

Average	167
Std Dev	379
95% UCL	479

*Subsurface Lead Results (mg/kg)*

<u>Location</u>	<u>Depth</u>	<u>Concentration</u>
SB10-1	2-4'	1000
SB10-2	6-8'	9.4
SB10-3	4-6'	5.4
SB10-4	6-8'	13
SB10-5	14-16'	3.9
MW10-1	10-12'	4.8

Average	173
Std Dev	405
95% UCL	506

*Surface Asbestos Results (%)*

<u>Location</u>	<u>Depth</u>	<u>Concentration</u>
SS10-1	0-1'	10%
SS10-2	0-1'	10%

*Subsurface Asbestos Results (%)*

<u>Location</u>	<u>Depth</u>	<u>Concentration</u>
SB10-1	2-4'	8%
SB10-2	6-8'	<1%
SB10-3	4-6'	<1%
SB10-4	6-8'	<1%
SB10-5	14-16'	<1%
MW10-1	10-12'	<1%



**TABLE 13**  
**GROUNDWATER FREQUENCY SUMMARY**  
**ON-SITE AND OFF-SITE GROUNDWATER DATA**  
**GENERAL MOTORS-ALLISON PLANT 10**

ID DATE	MW-10-1 2/5/97	MW-132 2/5/97	MW-133 2/5/97	MW-135 2/5/97	MW-145 2/5/97	MW-146 2/5/97
<u>UNIT</u>						
Vinyl Chloride ug/L	5 U	125 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane ug/L	2.5 U	60 U	2.5 U	2.5 U	2.5 U	2.5 U
cis-1,2-Dichloroethene ug/L	120	65000	100	2.5 U	2.5 U	2.5 U
Trichloroethene ug/L	810	15000	53	2.5 U	43	43

ID DATE	MW-147 2/5/97	MW-148 2/5/97	MW-150 2/5/97	MW-151 * 2/6/97	MW-152 2/5/97	MW-153 2/6/97
<u>UNIT</u>						
Vinyl Chloride ug/L	5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane ug/L	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
cis-1,2-Dichloroethene ug/L	95	73	2.5 U	20	2.5 U	2.5 U
Trichloroethene ug/L	51	2.5 U	86	2.5 U	150	5.4

NOTE: "\*" Designates an off-site well southeast of the site where off-site potential exposures exist.

**TABLE 13**  
**GROUNDWATER FREQUENCY SUMMARY**  
**ON-SITE AND OFF-SITE GROUNDWATER DATA**  
**GENERAL MOTORS-ALLISON PLANT 10**

ID DATE	MW-154 2/5/97	MW-155 2/6/97	MW-156 * 2/6/97	MW-157 * 2/26/97	MW-158 2/6/97	MW-200 2/5/97
<u>UNIT</u>						
Vinyl Chloride ug/L	5 U	3400	5 U	10 U	5 U	5 U
1,1-Dichloroethane ug/L	2.5 U	250 U	2.5 U	5 U	2.5 U	2.5 U
cis-1,2-Dichloroethene ug/L	2.5 U	17000	7.5	5 U	2.5 U	2.5 U
Trichloroethene ug/L	2.5 U	250 U	52	100	2.5 U	2.5 U

ID DATE	MW-201 2/6/97	MW-202 2/6/97	MW-301 2/6/97	MW-302 2/6/97	HP-1 9/6/95
<u>UNIT</u>					
Vinyl Chloride ug/L	5 U	5 U	5 U	5 U	500
1,1-Dichloroethane ug/L	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
cis-1,2-Dichloroethene ug/L	2.5 U	2.5 U	2.5 U	8.2	3900
Trichloroethene ug/L	2.5 U	2.5 U	2.5 U	2.5 U	430

NOTES: "\*" Designates an off-site well southeast of the site where off-site potential exposures exist.  
Sample MW-157 was resampled on 2/26/97 due to a high detection limit for vinyl chloride in the sample collected on 2/6/97. The TCE concentration in this well represents the worst-case off-site groundwater concentration for parameters exceeding the IDEM residential land use health-based criteria for groundwater.

**TABLE 13**  
**GROUNDWATER FREQUENCY SUMMARY**  
**ON-SITE AND OFF-SITE GROUNDWATER DATA**  
**GENERAL MOTORS-ALLISON PLANT 10**

ID DATE	MINIMUM DETECTED	MAXIMUM DETECTED	LOCATION OF MAXIMUM DETECTED	FREQUENCY OF DETECTION
<u>UNIT</u>				
Vinyl Chloride ug/L	500	3400	MW-155	2/23
1,1-Dichloroethane ug/L	ND	ND		0/23
cis-1,2-Dichloroethene ug/L	7.5	65000	MW-132	10/23
Trichloroethene ug/L	5.4	15000	MW-132	12/23

ID DATE	UNIT
Vinyl Chloride ug/L	
1,1-Dichloroethane ug/L	
cis-1,2-Dichloroethene ug/L	
Trichloroethene ug/L	



**TABLE 14**  
**CALCULATION OF SOIL-TO-AIR VOLATILIZATION FACTOR AND PARTICULATE EMISSIONS FACTOR**  
**FOR USE IN DETERMINING INHALATION OF VOLATILES FROM SOILS EXPOSURES**  
**GENERAL MOTORS - ALLISON PLANT 10**

<i>Input Paramet</i>	<i>Abbrev.</i>	<i>Value</i>	<i>Units</i>	<i>Source</i>
LENGTH OF AREA	LS	250	m	Estimated
WIND SPEED -MIX ZONE	V	2.25	m/sec	Default
DIFFUSION HEIGHT	DH	2	m	Default
AREA IMPACTED	A	150,000,000	cm^2	Estimated
SOIL POROSITY	E	0.35	unitless	Default
FRACTION OF VEGETATIVE COVER	G	0.95	unitless	Estimated
EFFECTIVE DIFFUSIVITY	Dei	Di * E^0.33	cm^2/sec	Default
SOIL/AIR PARTITION	Kas	H/Kd * 41	g soil/cm^3 air	Default
PARTICULATE DENSITY	Ps	2.65	g/cm^3	Default
EXPOSURE INTERVAL	T	7.9E+08	sec	Default (25 yrs)
MOLECULAR DIFFUSIVITY	Di	chem-spec	cm^2/sec	Lookup
HENRY'S LAW CONSTANT	H	chem-spec	atm-m^3/mol	Lookup
SOIL-WATER PARTITION	Kd	chem-spec	cm^3/g	Koc x OC
ORGANIC CARBON PARTITION	Koc	chem-spec	cm^3/g	Lookup
ORGANIC CARBON CONTENT	OC	0.02	unitless	Default
RESPIRABLE FRACTION	RF	0.036	g/m^2-hr	Default
MEAN ANNUAL WIND SPEED	Um	4.5	m/sec	Default
THRESHOLD WIND SPEED @ 10 M	Ut	18	m/sec	Estimated

Formulae ==>  $\alpha \text{ (cm}^2\text{/sec)} = (Dei \times E) / [E + (Ps) \times (1-E) / Kas]$   
 $VF \text{ (m}^3\text{/Kg)} = [(LS \times V \times DH) / A] \times [(3.14 \times \alpha \times T)^{0.5} / (2 \times Dei \times E \times Kas \times 10^{-3} \text{ kg/g})]$   
 $PEF \text{ (m}^3\text{/Kg)} = [(LS \times V \times DH \times 3600) / A] \times [(1000 \text{ g/Kg} / (.036 \times (1-G) \times (Um/Ut)^3 \times F(x))]$

<i>Constituent</i>	<i>VF Intermediate Calculated Inputs</i>						<i>Outputs</i>		
	Dei	Kas	DI	H	Kd	Koc	alpha	VF	PEF
Vinyl Chloride	7.50E-02	3.08E+00	1.06E-01	8.42E-02	1.12E+00	56	2.89E-02	392	1.70E+12

Note: Most chemical-specific input values were taken from the Technical Background Document for Soil Screening Guidance, Review Draft. EPA/540/R-94/106.  
The Koc value was estimated using Equation 4-5 from the Handbook of Chemical Property Estimation Methods (Lyman et al. 1993).



**TABLE 15**  
**CALCULATION OF GROUNDWATER-TO-INDOOR AIR VOLATILIZATION CONCENTRATIONS**  
**FOR USE IN DETERMINING INHALATION OF VOLATILES FROM OFF-SITE GROUNDWATER EXPOSURES**  
**GENERAL MOTORS - ALLISON PLANT 10**

Parameter	Definition	Units	Value	Basis
<b>Site-Specific Parameters</b>				
hcap	thickness of capillary fringe	cm	5	ASTM default
hv	thickness of vadose zone	cm	150	Site-specific
Vi	total soil porosity	cm <sup>3</sup> /cm <sup>3</sup> -soil	0.35	Default
p	soil particle density	g/cm <sup>3</sup>	2.65	Default
pb	dry bulk density of soil	g/cm <sup>3</sup>	1.45	Default
w	moisture content of soil	unitless	0.15	Estimated
Vacrack	volumetric air content in foundation walls/cracks	cm <sup>3</sup> -air/cm <sup>3</sup> total volume	0.133	ASTM default
Vwcrack	volumetric water content in foundation walls/cracks	cm <sup>3</sup> -water/cm <sup>3</sup> total volume	0.218	Vi-Vacrack
Vacap	volumetric air content in capillary fringe soils	cm <sup>3</sup> -air/cm <sup>3</sup> soil	0.038	ASTM default
Vwcap	volumetric water content in capillary fringe soils	cm <sup>3</sup> -water/cm <sup>3</sup> soil	0.312	Vi-Vacap
Vas	volumetric air content in vadose zone soils	cm <sup>3</sup> -air/cm <sup>3</sup> soil	0.133	ASTM default
Vws	volumetric water content in vadose zone soils	cm <sup>3</sup> -water/cm <sup>3</sup> soil	0.218	Vi-Vas
Lgw	depth to groundwater	cm	155	Site-specific
Lb	enclosed space volume/infiltration area ratio	cm	200	ASTM default
Lcrack	enclosed space foundation or wall thickness	cm	15	ASTM default
ER	enclosed space air exchange rate	L/sec	0.00014	ASTM default
n	areal fraction of cracks in foundation walls/cracks	cm <sup>2</sup> -cracks/cm <sup>2</sup> -total area	0.01	ASTM default
<b>Chemical-Specific Parameters</b>				
Dair	diffusion coefficient in air	cm <sup>2</sup> /sec		chemical-specific
Dwater	diffusion coefficient in water	cm <sup>2</sup> /sec		chemical-specific
H	Henry's Law Constant	cm <sup>3</sup> -water/cm <sup>3</sup> -air		chemical-specific
Cwater	groundwater concentration	mg/L		chemical-specific
<b>Calculated Parameters</b>				
Deflws	effective diffusion coefficient between groundwater and soil surface	cm <sup>2</sup> /sec		chemical-specific
Deflcap	effective diffusion coefficient through capillary fringe	cm <sup>2</sup> /sec		chemical-specific
Defls	effective diffusion coefficient in soil based on vapor-phase concentration	cm <sup>2</sup> /sec		chemical-specific
Deflcrack	effective diffusion coefficient through foundation cracks	cm <sup>2</sup> /sec		chemical-specific
VFwesp	volatilization factor for groundwater to enclosed space vapors	(mg/m <sup>3</sup> -air) / (mg/L-water)		chemical-specific
Calr	air concentration	mg/m <sup>3</sup>		chemical-specific

**Formulas**

$$\begin{aligned}
 \text{Deflws} &= (hcap + hv) / [hcap / \text{Deflcap} + hv / \text{Defls}] \\
 \text{Deflcrack} &= Dair * \text{Vacrack}^{3.33} / Vi^{1/2} + (Dwater * \text{Vwcrack}^{3.33}) / (H * Vi^{1/2}) \\
 \text{Deflcap} &= Dair * \text{Vacap}^{3.33} / Vi^{1/2} + (Dwater * \text{Vwcap}^{3.33}) / (H * Vi^{1/2}) \\
 \text{Defls} &= Dair * \text{Vas}^{3.33} / Vi^{1/2} + (Dwater * \text{Vws}^{3.33}) / (H * Vi^{1/2}) \\
 \text{VFwesp} &= H * [ \text{Deflws} / (Lgw * ER * Lb) ] + [ (\text{Deflws} * Lcrack) / (\text{Deflcrack} * Lgw * n) ] \\
 \text{Calr} &= \text{Cwater} * \text{VFwesp}
 \end{aligned}$$

Chemical	Dair	Dwater	H	Deflws	Deflcrack	Deflcap	Defls	VFwesp	Cwater	Calr
Trichloroethene	0.079	9.10E-08	0.435	3.00E-04	7.71E-04	1.58E-05	7.71E-04	8.31E-03	0.10	8.31E-04

The Calr concentrations represent the estimated concentrations in air (from volatilized vapor) based on representative groundwater concentrations of the constituents of interest. The Calr values are then used to calculate an estimated risk from exposure to these estimated concentrations in air.

**TABLE 17**  
**SUMMARY OF CARCINOGENIC AND NON-CARCINOGENIC HUMAN HEALTH RISKS**  
**INHALATION OF VOLATILES AND SOIL PARTICULATES AND INGESTION OF SITE SUBSURFACE SOILS**  
**BASED ON RESULTS OF ON-SITE SUBSURFACE SOIL DATA**  
**INDUSTRIAL NON-RESIDENTIAL EXPOSURES FOR ON-SITE WORKERS**

CONSTITUENTS	PEF (m <sup>3</sup> /Kg)	CF (10 <sup>-3</sup> mg/ug)	VF (m <sup>3</sup> /Kg)	EF (d/yr)	ED (yrs)	IRair (m <sup>3</sup> /day)	BW (Kg)	AT Carc. (day)	AT Ncarc. (day)	INH Carc. CDI	INH Ncarc. CDI	CSF (Kg-d/ mg)	RfD (mg/ Kg-d)	INH ICR	INH HI
Vinyl Chloride	1.70E+12	1.00E-03	392	120	2	15	70	25550	730	9.65E-07	3.38E-05	0.3		2.90E-07	0.00E+00

INHALATION TOTAL ==> 2.90E-07 0.00E+00

CONSTITUENTS	IRsoil (mg/d)	EF (d/yr)	ED (yr)	BW (Kg)	AT Carc. (day)	AT Ncarc. (day)	CF 10 <sup>-9</sup> Kg/ug	ING Carc. CDI	ING Ncarc. CDI	CSF (Kg-d/ mg)	RfD (mg/ Kg-d)	ING ICR	ING HI
Vinyl Chloride	100	120	2	70	25550	730	1.00E-09	2.52E-09	8.83E-08	1.9		4.79E-09	0.00E+00

INGESTION TOTAL = 4.79E-09 0.00E+00

TOTAL == 2.94E-07 0.00E+00



**TABLE 18**  
**SUMMARY OF CARCINOGENIC AND NON-CARCINOGENIC HUMAN HEALTH RISKS**  
**INHALATION OF VOLATILES AND SOIL PARTICULATES AND INGESTION OF SITE SOILS**  
**BASED ON RESULTS OF ON-SITE SUBSURFACE SOIL DATA**  
**INDUSTRIAL NON-RESIDENTIAL EXPOSURES FOR ON-SITE CONSTRUCTION WORKERS**

$$CDI_{inh} = [(CW)(EF)(ED)(IR_{air})(CF)(1/VF + 1/PEF)]/[(BW)(AT)]$$

$$CDI_{ing} = [(CW)(IR_{soil})(CF)(EF)(ED)]/[(BW)(AT)]$$

WHERE:

- CW = THE CHEMICAL CONCENTRATION (ug/Kg)
- VF = SOIL TO AIR VOLATILIZATION FACTOR (m<sup>3</sup>/Kg)
- PEF = PARTICULATE EMISSION FACTOR (m<sup>3</sup>/Kg)
- EF = THE EXPOSURE FREQUENCY (d/yr)
- ED = THE EXPOSURE DURATION (years)
- CF = CONVERSION FACTOR (10<sup>-9</sup> Kg/ug or 10<sup>-3</sup> mg/ug)
- BW = THE AVERAGE RECEPTOR BODY WEIGHT (Kg)
- AT = THE AVERAGING TIME (ED (yrs) x 365d/yr)
- IR<sub>air</sub> = THE AIR INGESTION RATE (m<sup>3</sup>/d)
- IR<sub>soil</sub> = THE SOIL INGESTION RATE (mg/d)

$$ICR = \text{SUM}(CDI \cdot CSF) \text{ (inhalation or ingestion)}$$

$$\text{HAZARD INDEX} = \text{SUM}(CDI / RfDi) \text{ (inhalation or ingestion)}$$

$$\text{TOTAL ICR} = ICR_{inh} + ICR_{ing}$$

$$\text{TOTAL HI} = HI_{inh} + HI_{ing}$$

CDI = CHRONIC DAILY INTAKE (per constituent)  
 inh = VIA INHALATION EXPOSURE  
 ing = VIA INGESTION EXPOSURE  
 HI = HAZARD INDEX (non-carcinogenic risks)  
 ICR = INCREMENTAL CANCER RISK (carcinogenic risks)  
 CSF = CANCER SLOPE FACTOR (per constituent)  
 RfDi = REFERENCE DOSE (per constituent)

CONSTITUENTS	CW * (ug/Kg)	EPA WEIGHT OF EVIDENCE
Vinyl Chloride	188	A

\* - The CW value for the on-site subsurface soils is the 95% UCL calculated for the 21 on-site vadose zone subsurface soil samples collected.



**TABLE 18**  
**SUMMARY OF CARCINOGENIC AND NON-CARCINOGENIC HUMAN HEALTH RISKS**  
**INHALATION OF VOLATILES AND SOIL PARTICULATES AND INGESTION OF SITE SOILS**  
**BASED ON RESULTS OF ON-SITE SUBSURFACE SOIL DATA**  
**INDUSTRIAL NON-RESIDENTIAL EXPOSURES FOR ON-SITE CONSTRUCTION WORKERS**

CONSTITUENTS	PEF (m <sup>3</sup> /Kg)	CF (10 <sup>-3</sup> mg/ug)	VF (m <sup>3</sup> /Kg)	EF (d/yr)	ED (yrs)	IRair (m <sup>3</sup> /day)	BW (Kg)	AT Carc. (day)	AT Ncarc. (day)	INH Carc. CDI	INH Ncarc. CDI	CSF (Kg-d/ mg)	RfD (mg/ Kg-d)	INH ICR	INH HI
Vinyl Chloride	1.70E+12	1.00E-03	392	120	0.5	24	70	25550	183	3.86E-07	5.41E-05	0.3		1.16E-07	0.00E+00

INHALATION TOTAL ==> 1.16E-07 0.00E+00

CONSTITUENTS	IRsoil (mg/d)	EF (d/yr)	ED (yr)	BW (Kg)	AT Carc. (day)	AT Ncarc. (day)	CF (10 <sup>-9</sup> Kg/ug)	ING Carc. CDI	ING Ncarc. CDI	CSF (Kg-d/ mg)	RfD (mg/ Kg-d)	ING ICR	ING HI
Vinyl Chloride	100	120	0.5	70	25550	183	1.00E-09	6.31E-10	8.83E-08	1.9		1.20E-09	0.00E+00

INGESTION TOTAL == 1.20E-09 0.00E+00

TOTAL == 1.17E-07 0.00E+00



**TABLE 19**  
**SUMMARY OF NON-CARCINOGENIC HUMAN HEALTH RISKS**  
**INCIDENTAL INGESTION OF AND DERMAL CONTACT WITH SURFACE WATER**  
**BASED ON RESULTS OF MAXIMUM SAMPLE LOCATION (ST-2)**  
**ADOLESCENT RESIDENTIAL EXPOSURE**

$$CDI_{ing} = [(CW)(IR_{gw})(CF)(EF)(ED)] / [(BW)(AT)]$$

WHERE:

- CW = THE CHEMICAL CONCENTRATION (mg/L)
- SA = THE SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm<sup>2</sup>)
- PC = THE DERMAL PERMEABILITY CONSTANT (cm/hour)
- CF = VOLUMETRIC CONVERSION FACTOR FOR WATER (L/1000 cm<sup>3</sup>)
- EF = THE EXPOSURE FREQUENCY (events/year)
- ED = THE EXPOSURE DURATION (years)
- ET = THE EXPOSURE TIME (hours/event or day)
- BW = THE AVERAGE RECEPTOR BODY WEIGHT (Kg)
- AT = THE AVERAGING TIME (ED (yrs) x 365d/yr)
- CR = THE CONTACT RATE (L/hour)

$$ICR = \sum(CDI_i \cdot CSF_i) \text{ (Ingestion or dermal)}$$

$$HAZARD INDEX = \sum(CDI_i / RfDI_i) \text{ (Ingestion or dermal)}$$

$$TOTAL ICR = ICR_{ing} + ICR_{dermal}$$

$$TOTAL HI = HI_{ing} + HI_{dermal}$$

CDI<sub>i</sub> = CHRONIC DAILY INTAKE (per constituent)  
 ing = VIA INGESTION EXPOSURE  
 dermal = VIA DERMAL EXPOSURE  
 HI = HAZARD INDEX (non-carcinogenic risks)  
 ICR = INCREMENTAL CANCER RISK (carcinogenic risks)  
 CSF<sub>i</sub> = CANCER SLOPE FACTOR (per constituent)  
 RfDI = REFERENCE DOSE (per constituent)

CONSTITUENTS	CW * (mg/L)	EPA WEIGHT OF EVIDENCE
cis-1,2-Dichloroethen	0.017	D

\* - The CW values for the surface water exposure is the maximum detected result obtained from the first sampling event at station ST-2.

**TABLE 19**  
**SUMMARY OF NON-CARCINOGENIC HUMAN HEALTH RISKS**  
**INCIDENTAL INGESTION OF AND DERMAL CONTACT WITH SURFACE WATER**  
**BASED ON RESULTS OF MAXIMUM SAMPLE LOCATION (ST-2)**  
**ADOLESCENT RESIDENTIAL EXPOSURE**

CONSTITUENTS	CR (L/hour)	EF (e/yr)	ED (yr)	BW (Kg)	AT Carc. (day)	AT carc. (day)	ET (hrs/e)		ING Carc. CDI	ING Ncarc. CDI	CSF (Kg-d/ mg)	RfD (mg/ Kg-d)	ING ICR	ING HI	% carc. Risk
cis-1,2-Dichloroethene	0.05	25	6	55.9	25550	2190	2		1.79E-07	2.08E-06		1E-02	0.00E+00	2.08E-04	100.0
INGESTION TOTAL =													0.00E+00	2.08E-04	100

CONSTITUENTS	PC (cm/hr)	CF (L/1000cc)	SA (cm^2)	EF (d/yr)	ED (yrs)	ET (hr/d)	BW (Kg)	AT Carc. (day)	AT Ncarc. (day)	DERMAL Carc. CDI	DERMAL Ncarc. CDI	CSF (Kg-d/mg)	RfD (mg/Kg-d)	DERMAL ICR	DERMAL HI	Perce Ncarc. Risk
cis-1,2-Dichloroethene	8.4E-04	1.00E-03	15800	25	6	2	55.9	25550	2190	4.74E-08	5.53E-07		1E-02	0.00E+00	5.53E-05	100.0
DERMAL TOTAL ==>														0.00E+00	5.53E-05	100

TOTAL ==> 0 2.64E-04

**TABLE 20**  
**SUMMARY OF CARCINOGENIC AND NON-CARCINOGENIC HUMAN HEALTH RISKS**  
**INHALATION OF VOLATILES ENTRUDING TO RESIDENCES**  
**FROM CONSTITUENTS DETECTED IN OFF-SITE GROUNDWATER**  
**GENERAL MOTORS - ALLISON PLANT 10**

**Carcinogens**

Intake(c) = ( Cair \* IRair \* EF \* ED ) / (BW \* ATc \* 365 days/year)  
 Risk = Intake \* CSFinh

Input Parameter	daily intake (dose) of carcinogen
Intake(c)	daily intake (dose) of noncarcinogen
Intake(nc)	inhalation rate
IRair	exposure frequency
EF	exposure duration
ED	body weight
BW	averaging time (carcinogen)
ATc	averaging time (noncarcinogen)
ATnc	inhalation cancer slope factor
CSFinh	inhalation reference dose
RfDinh	hazard quotient
HQ	risk level
Risk	

**Noncarcinogens**

Intake(nc) = ( Cair \* IRair \* EF \* ED ) / (BW \* ATnc \* 365 days/year)  
 Risk = Intake / RfDinh

Units	Value
mg/kg/day	--
mg/kg/day	--
m^3/day	15
days/year	350
years	30
kg	70
years	70
years	30
1/(mg/kg/day)	chemical specific
mg/kg/day	chemical specific
unitless	--
unitless	--

Chemical	Cair	RfDinh	CSFinh	Intake(nc)	HQ	Intake(c)	Risk
Trichloroethene	0.000631172	NA	0.006	1.30E-04	NA	0.0000555827	3.3E-07

**Hazard Index**

0.00E+00

**Risk Level**

3.3E-07

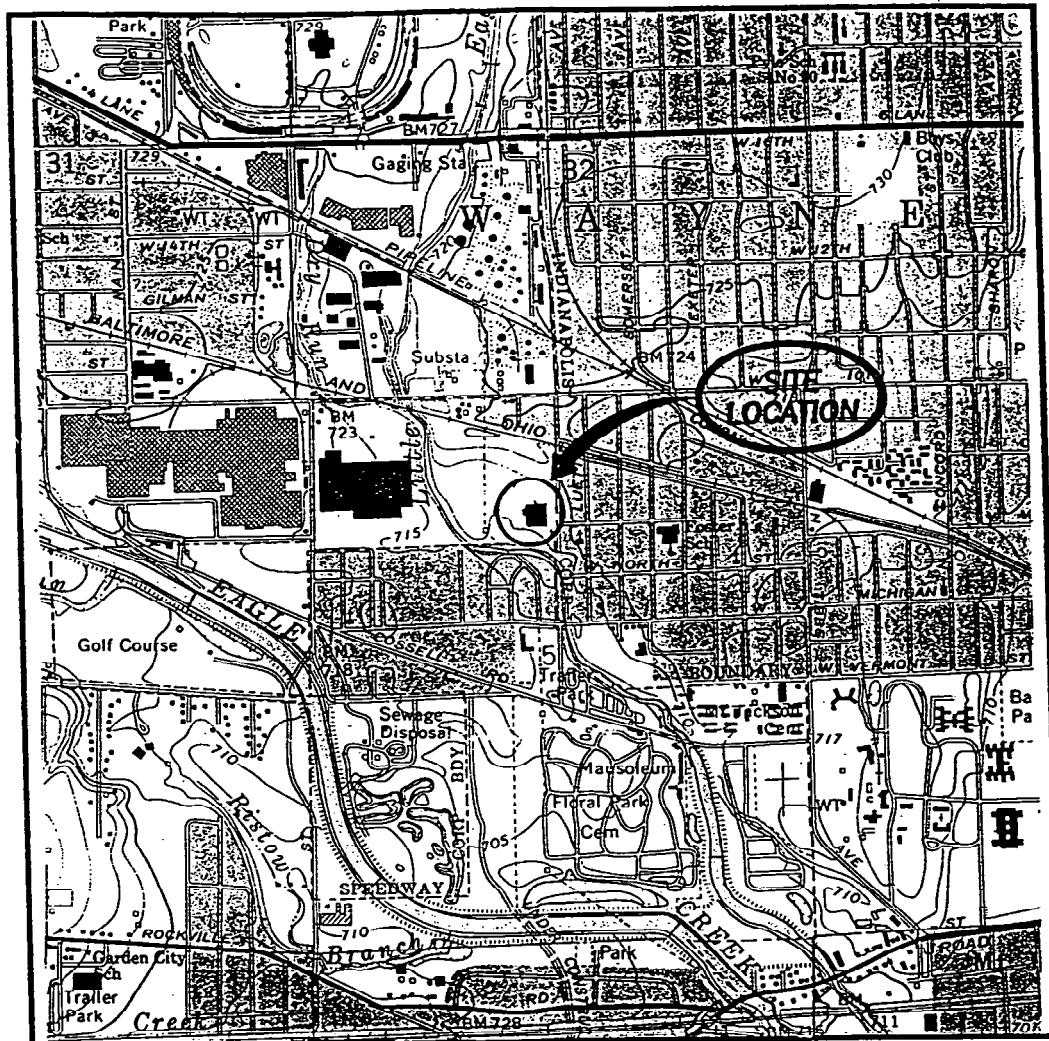


**TABLE 21**  
**SUMMARY OF CARCINOGENIC AND NON-CARCINOGENIC HUMAN HEALTH RISKS**  
**FOR ALL EXPOSURE PATHWAYS AND RECEPTOR GROUPS ASSESSED**  
**GENERAL MOTORS - ALLISON PLANT 10**

		Ingestion Haz Index	Total Haz Index	Inhalation Canc Risk	Ingestion Canc Risk	Total Canc Risk
On-Site Worker	Surface Soil	0.00E+00	0.00E+00	3.62E-06	3.00E-08	3.65E-06
	Subsurface Soil	0.00E+00	0.00E+00	2.90E-07	4.79E-09	2.95E-07
On-Site Construction Worker	Surface or Subsurface Soil	0.00E+00	0.00E+00	1.16E-07	1.20E-09	1.17E-07
Adult Resident	Groundwater-to- Indoor Air	--	N/A	3.30E-07	N/A	3.30E-07
		Ingestion Haz Index	Dermal Haz Index	Total Haz Index		
Adolescent Resident (12-18)	Surface Water	2.08E-04	5.53E-05	2.64E-04		



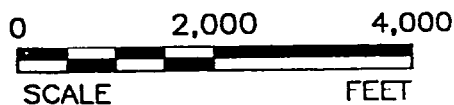
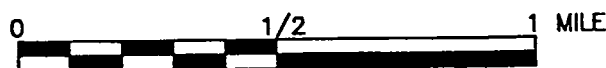




SOURCE: U.S.G.S. TOPOGRAPHIC QUADRANGLE  
INDIANAPOLIS WEST, INDIANA (1980)



SCALE 1:24,000



**FLUOR DANIEL QTI**  
6330 E. 75TH ST., STE 176  
INDIANAPOLIS, IN 46250  
(317) 595-6400

DESIGNED:

KG

DETAILED:

KG

CHECKED:

## SITE LOCATION MAP

CLIENT: GENERAL MOTORS CORPORATION  
ALLISON ENGINE COMPANY PLANT #10

LOCATION: 700 NORTH OLIN AVENUE  
INDIANAPOLIS, INDIANA

DRAWING DATE:  
6/1/95

FIGURE:  
1